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Moore

(10) **Patent No.: US 11,124,398 B2**
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(54) **TILT-SAFE, HIGH-CAPACITY LIFT DEVICE**

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Related U.S. Application Data

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(51) **Int. Cl.**
B66F 3/36 (2006.01)

(52) **U.S. Cl.**
CPC ***B66F 3/36*** (2013.01); *B66F 2700/052* (2013.01); *B66F 2700/055* (2013.01)

(58) **Field of Classification Search**
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USPC .... 254/93 H, 89 H, 93 R, 98, 100, 101, 102, 254/103, 133 R, 134
See application file for complete search history.

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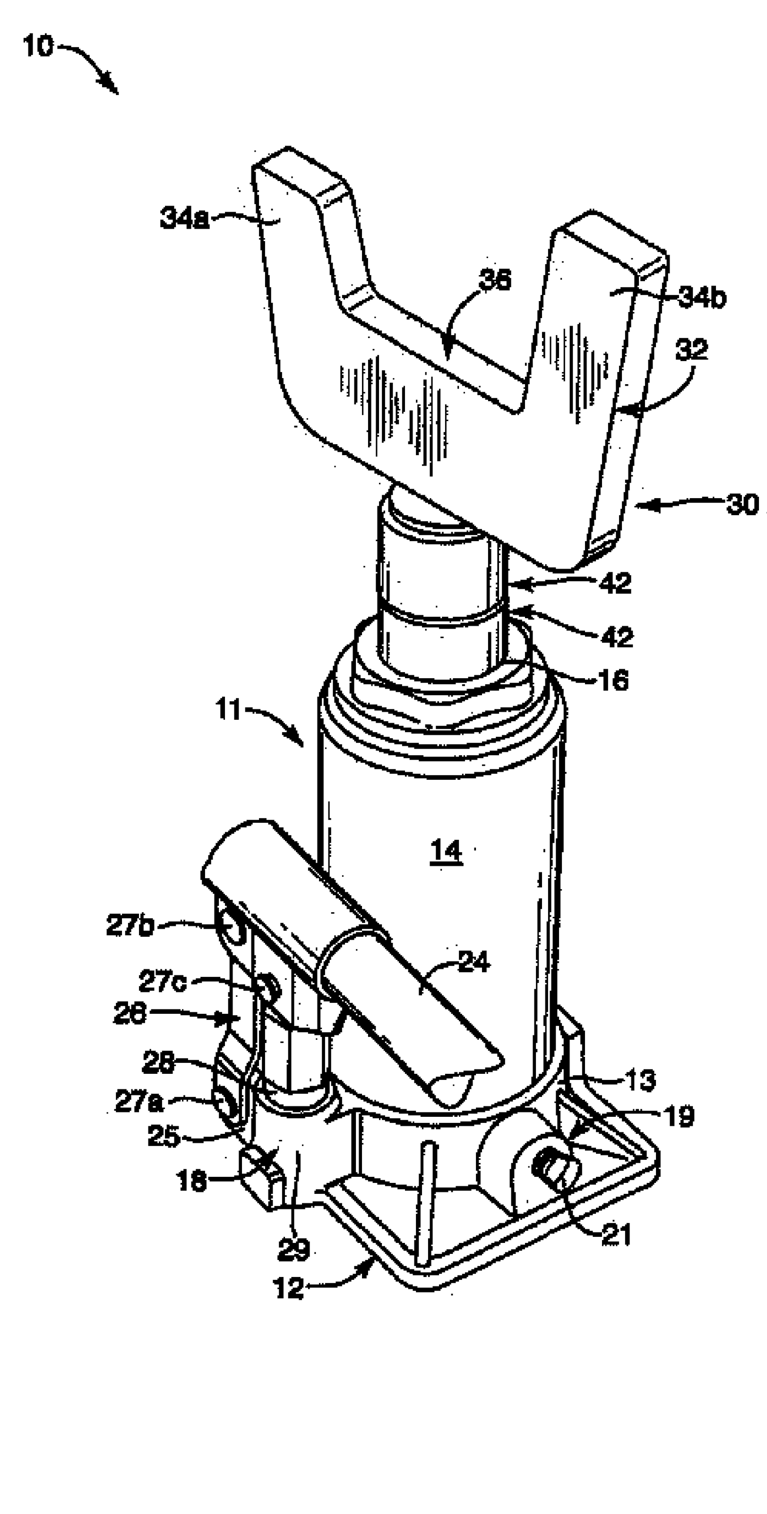
(74) *Attorney, Agent, or Firm* — QPatents

(57) **ABSTRACT**

A lifting device with a head cavity in the lifting member shaped to accept a removable lifting head. The head cavity in the lifting device—e.g., the piston of a bottle jack—may be provided with threads, or may have the threads removed. A yoke fitted on the lifting head provides registration, horizontal restraint, or both against a lifted object, component, or surface to prevent sliding off the lifting head while in use. In a smooth-walled-shaft embodiment, a set of risers (spacers, adjusters, trims, or shims) serves to adjust an extension height of the shaft, elevating the lifting head with respect to the piston prior to beginning to lift the hydraulic piston.

14 Claims, 14 Drawing Sheets



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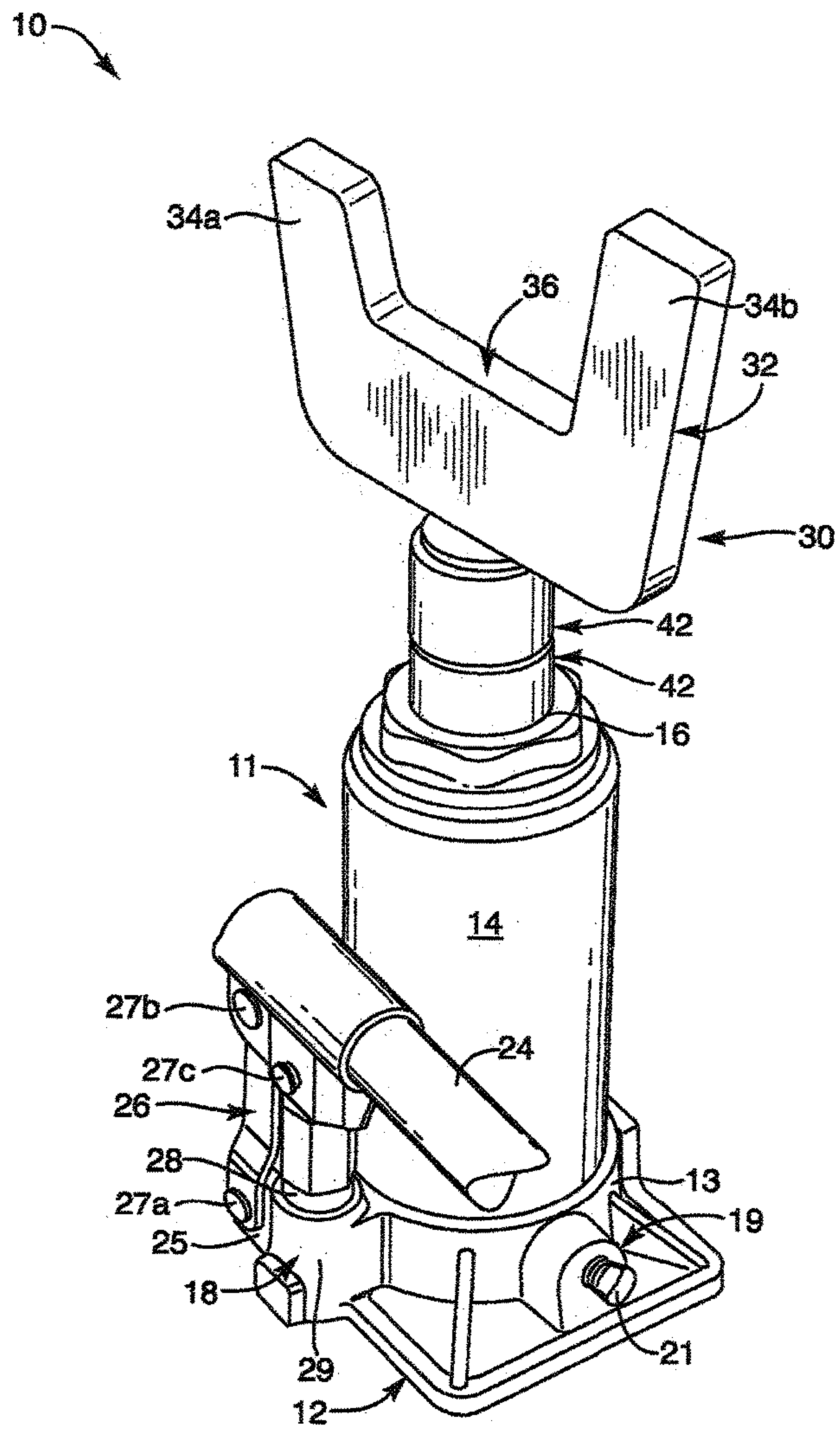
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FIG. 1

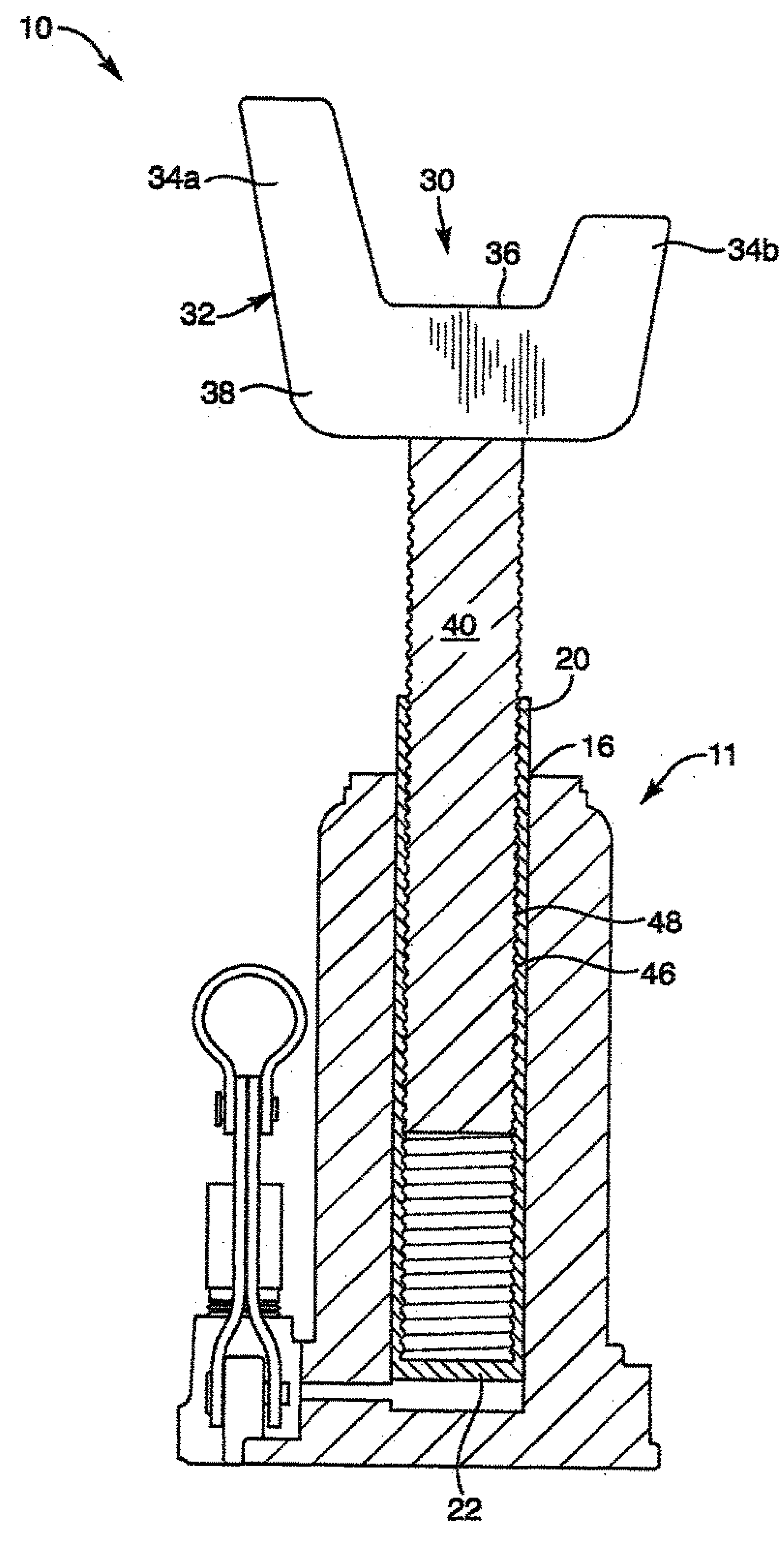
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FIG. 3

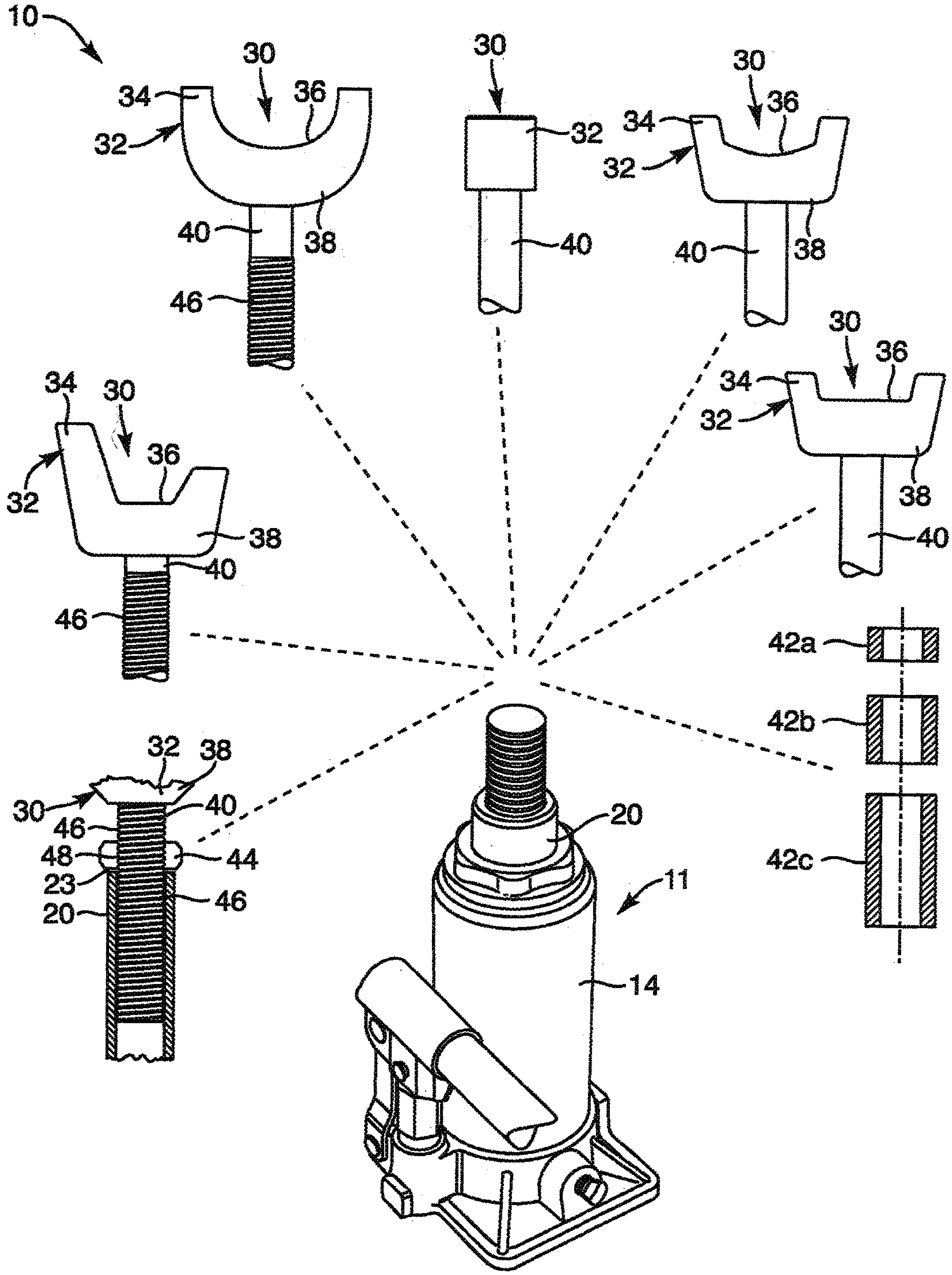
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FIG. 2

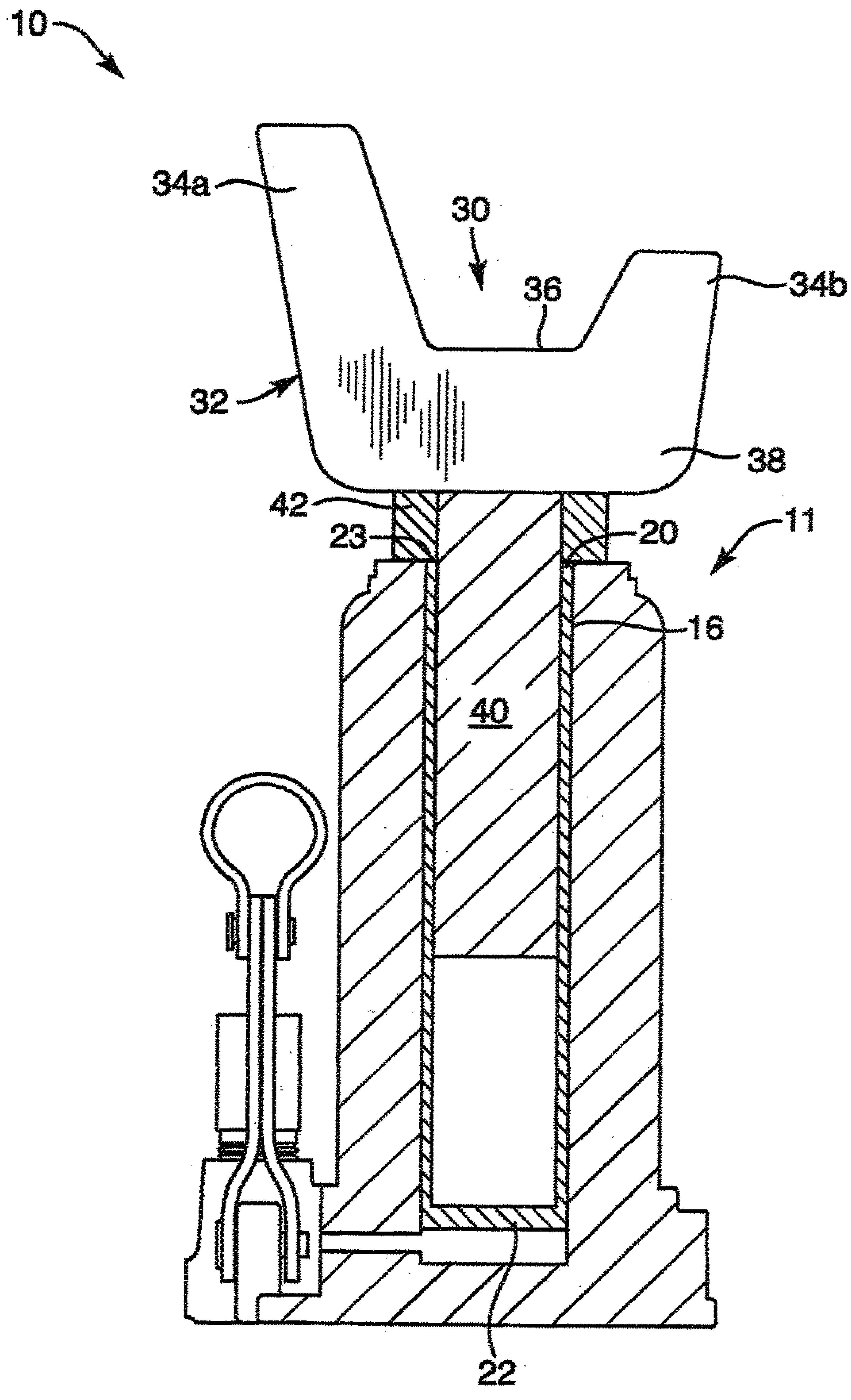

FIG. 4A

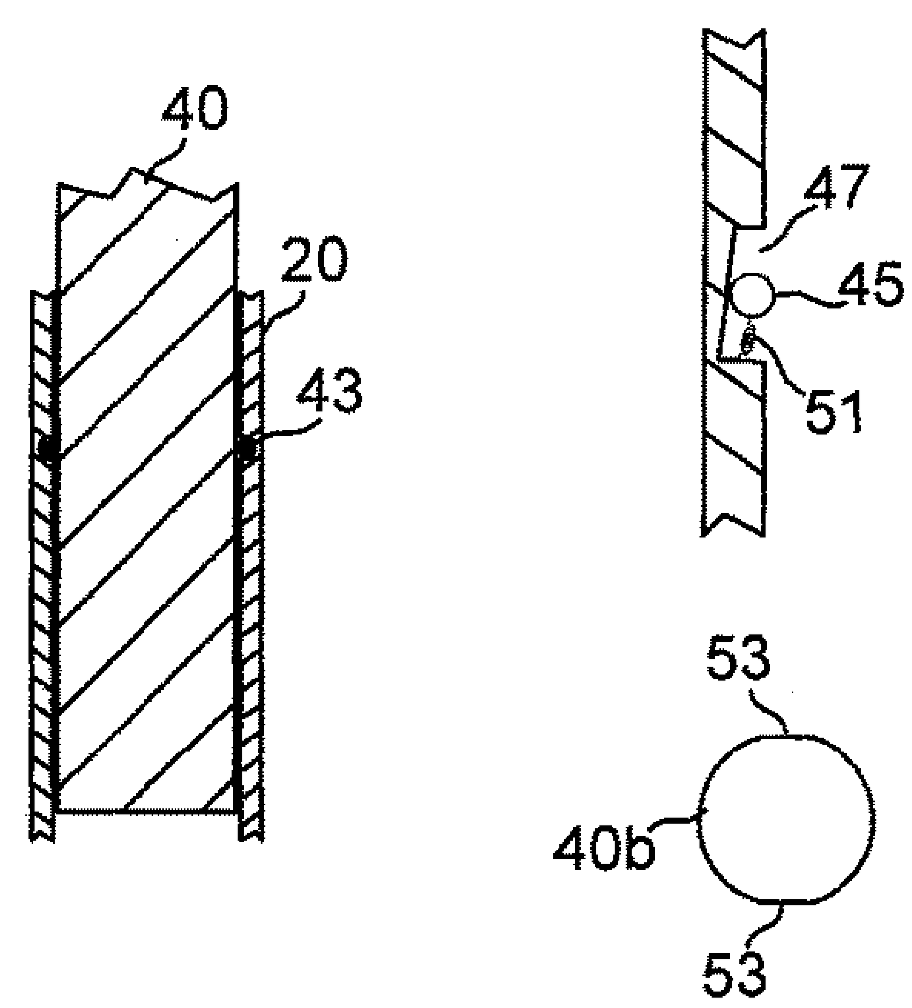

FIG. 4B

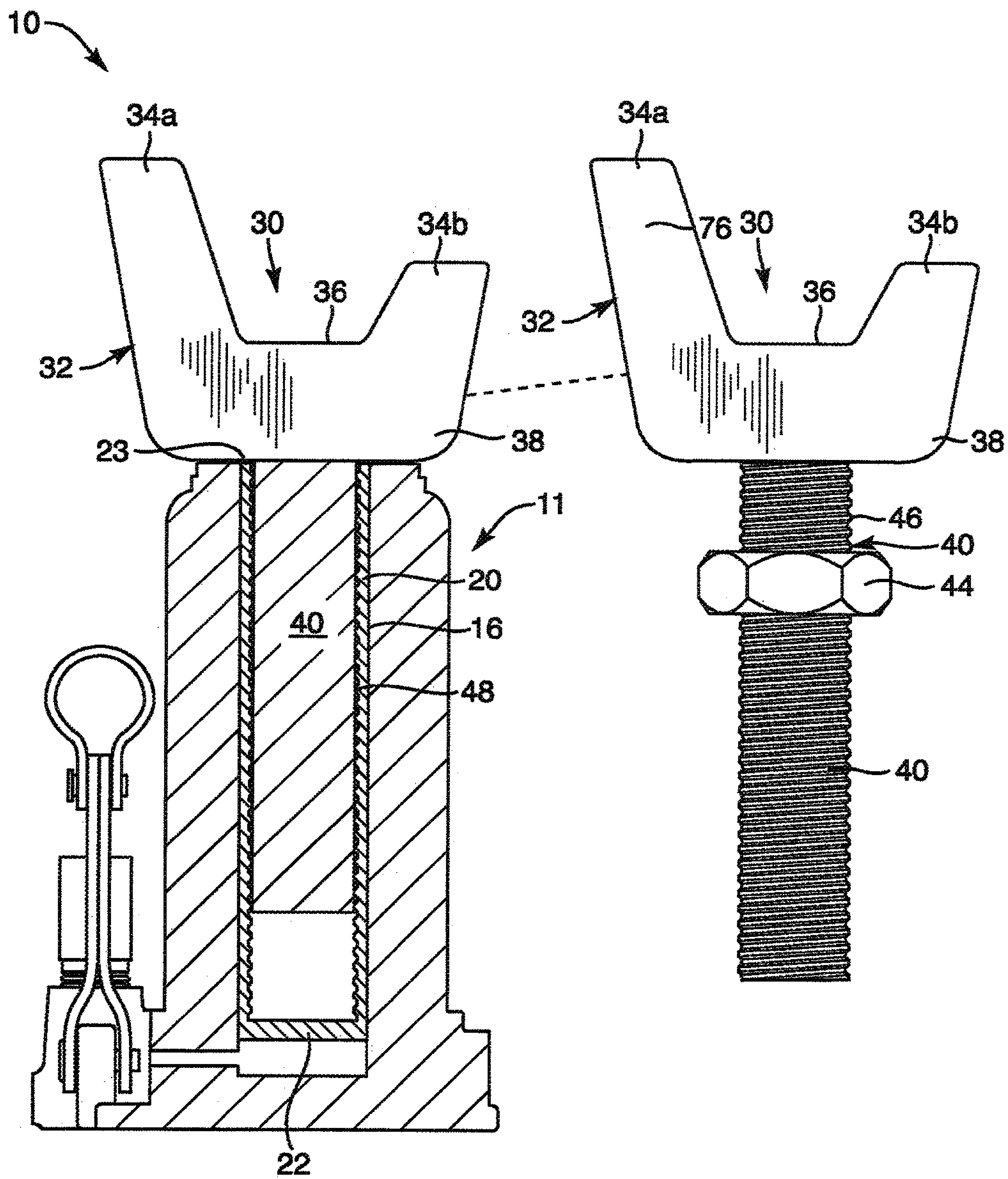
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FIG. 5A

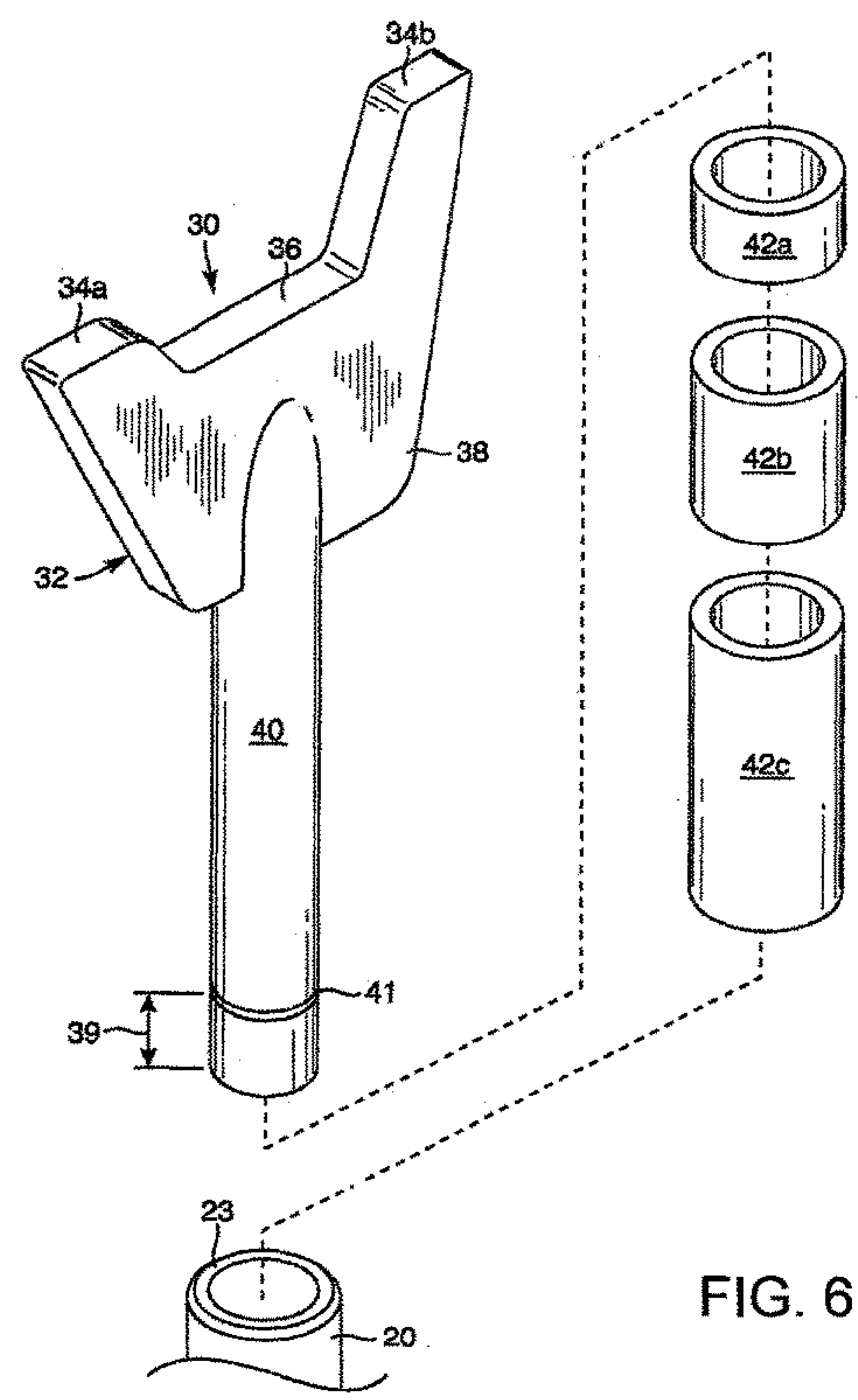


FIG. 6

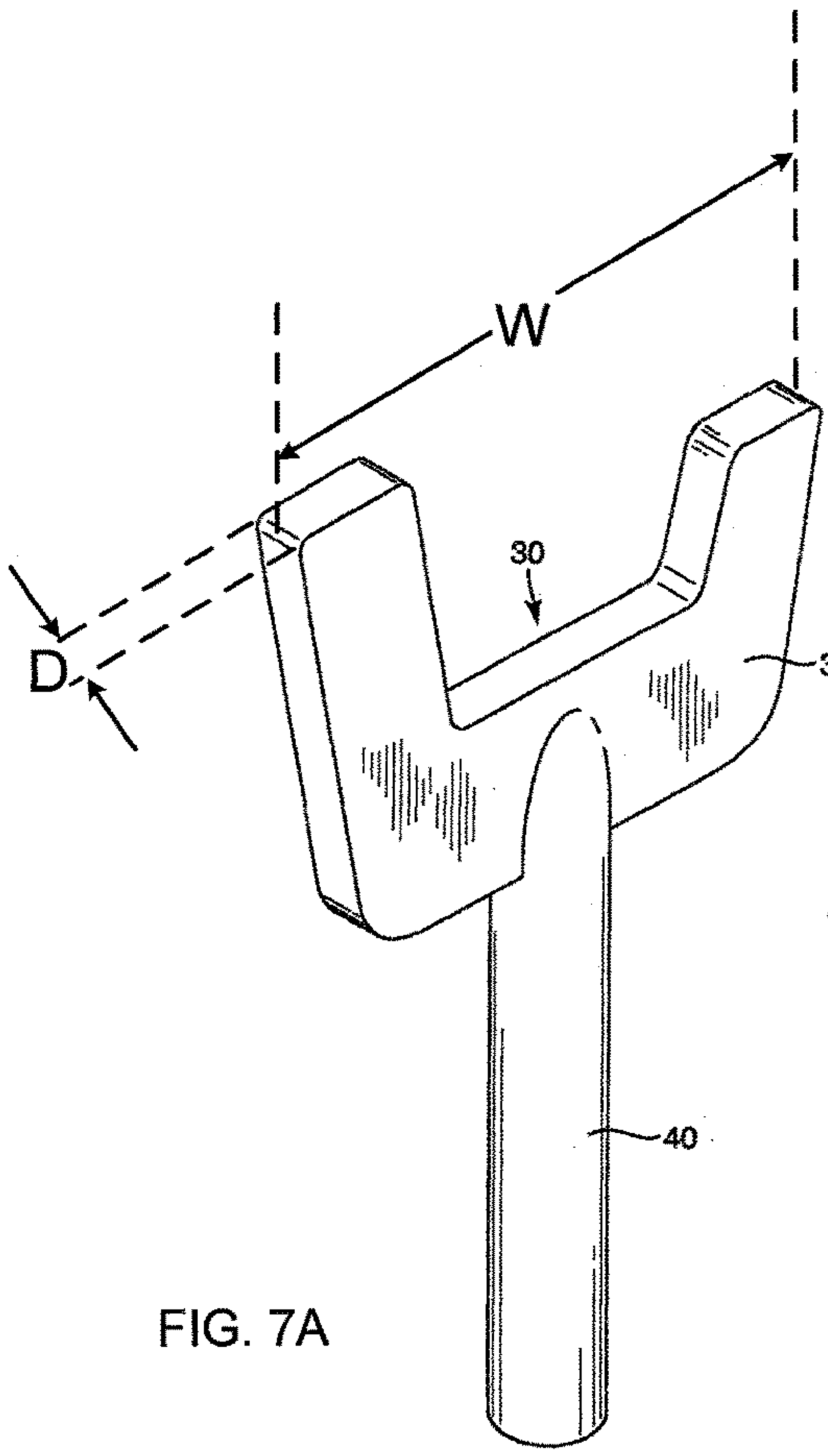


FIG. 7A

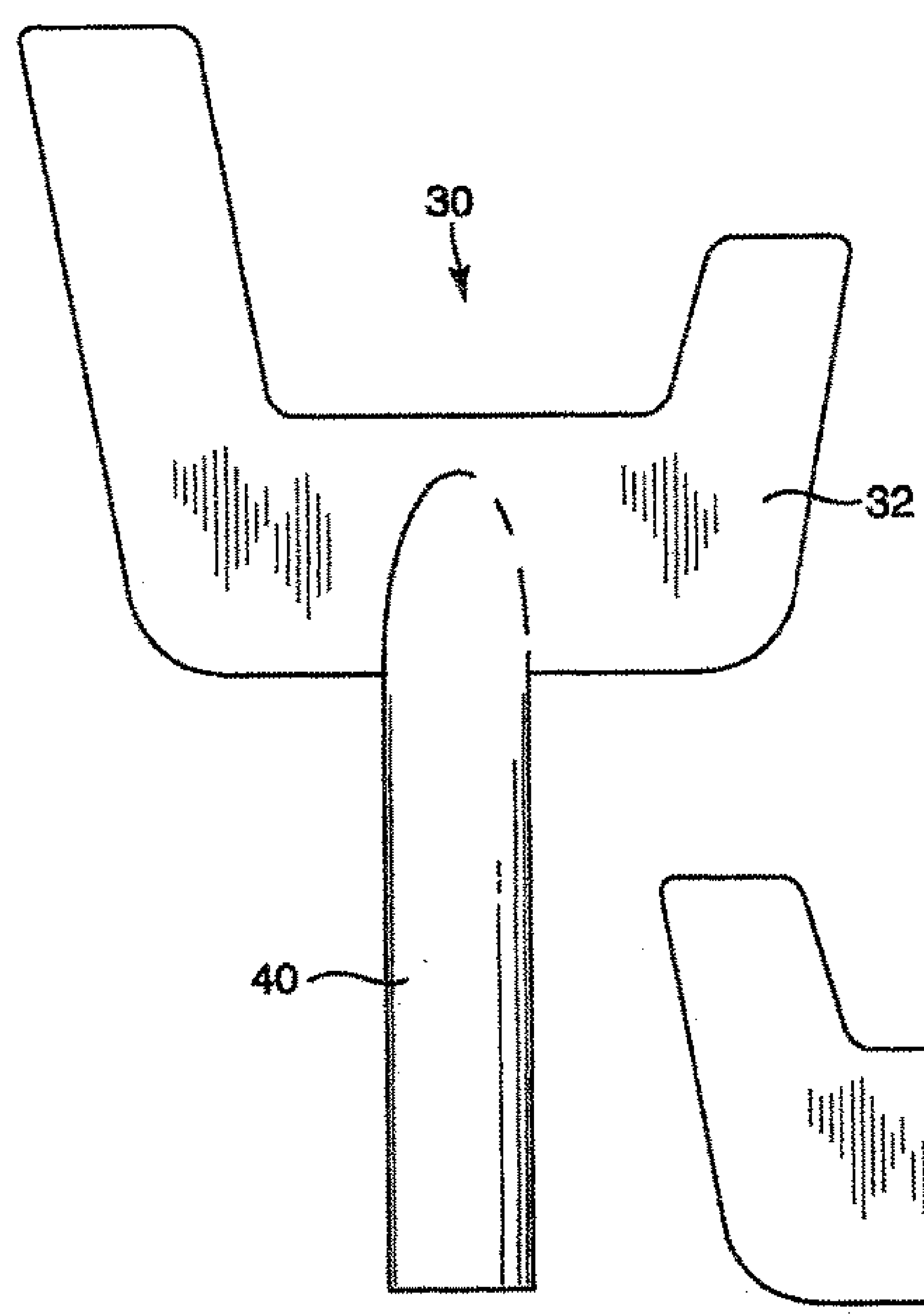


FIG. 7B

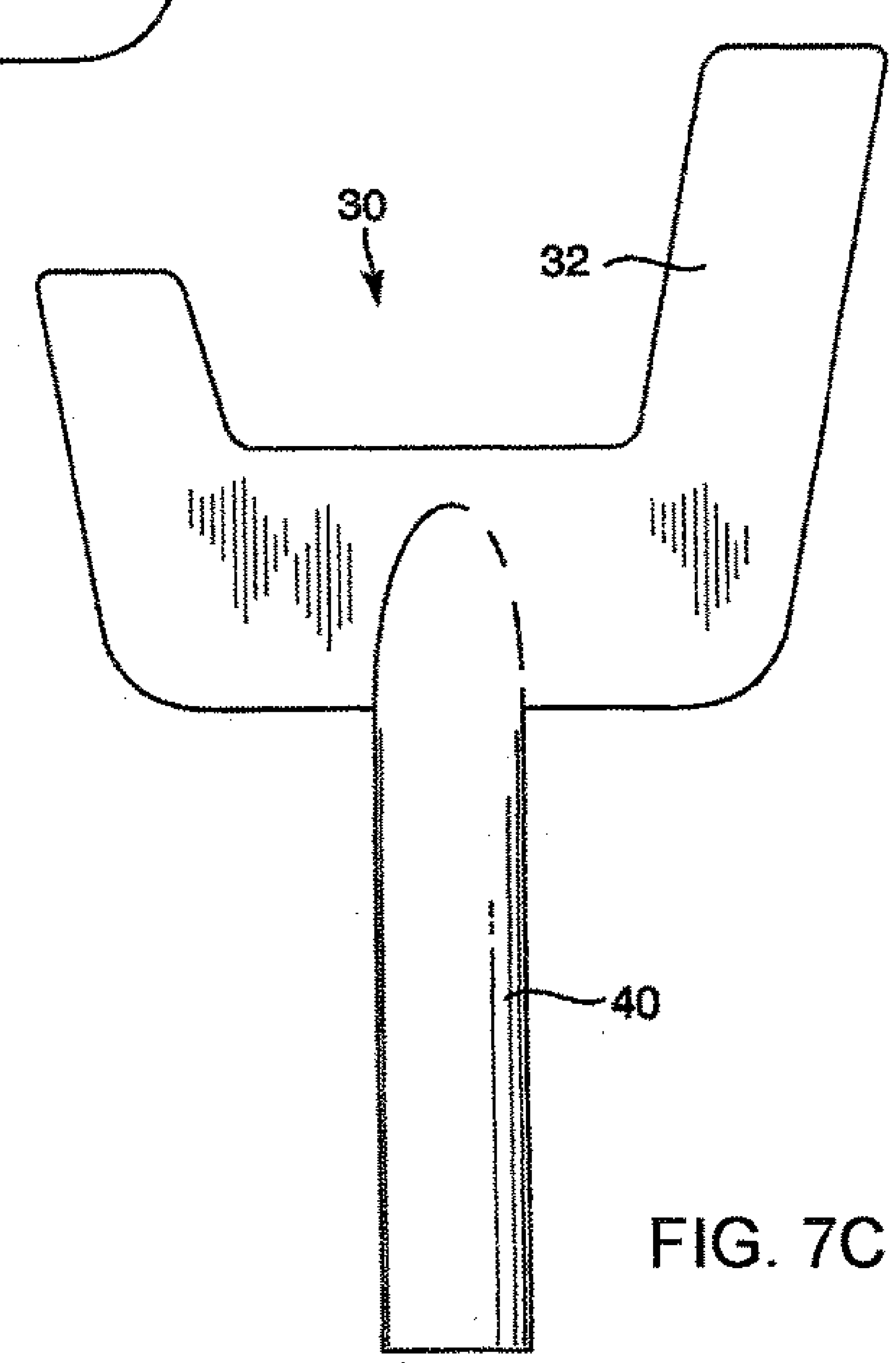


FIG. 7C

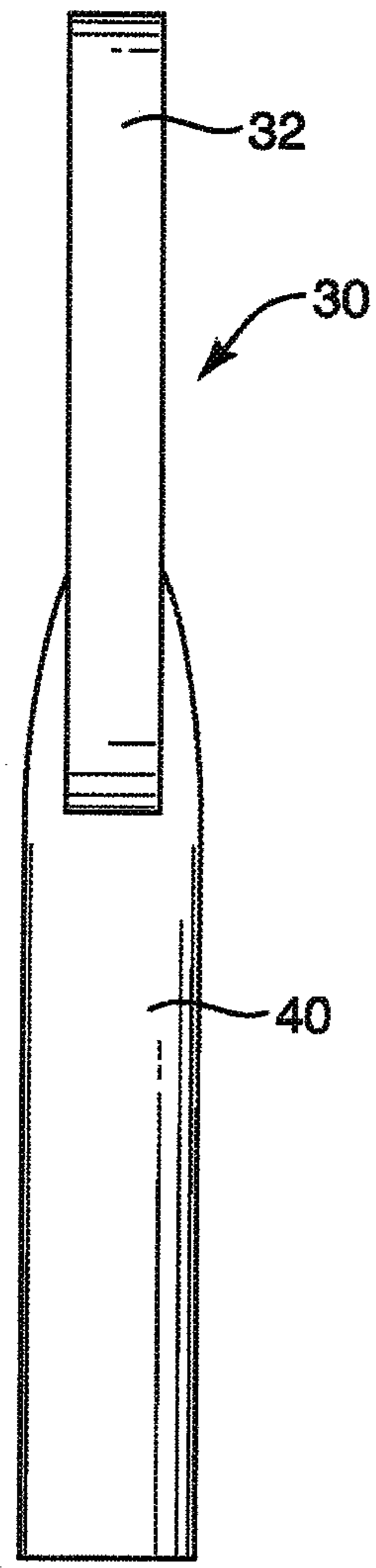


FIG. 7D

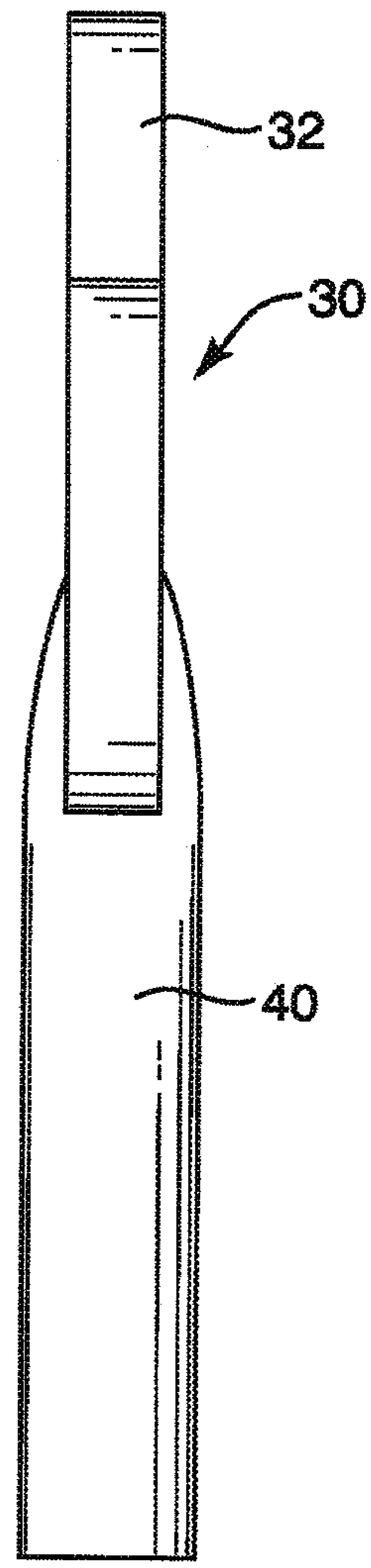


FIG. 7E

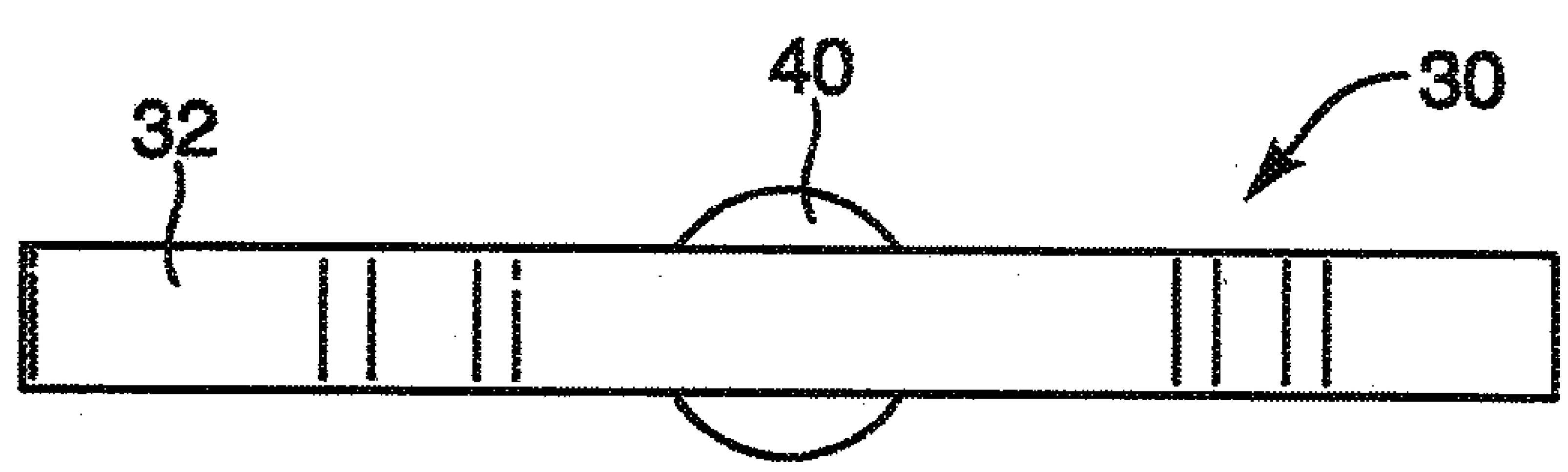


FIG. 7F

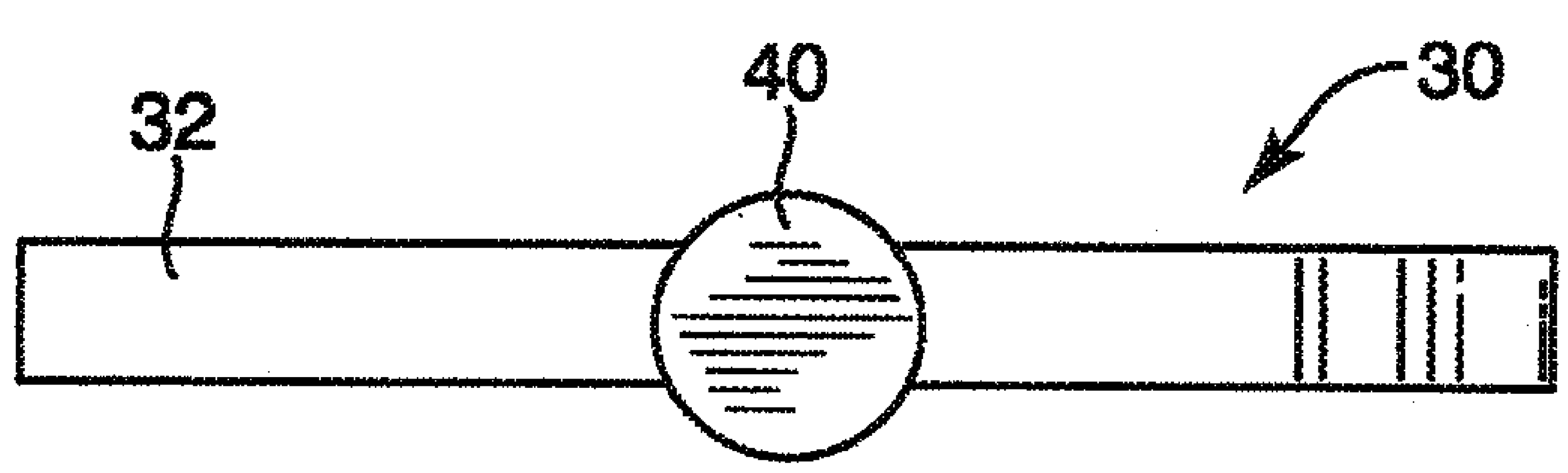


FIG. 7G

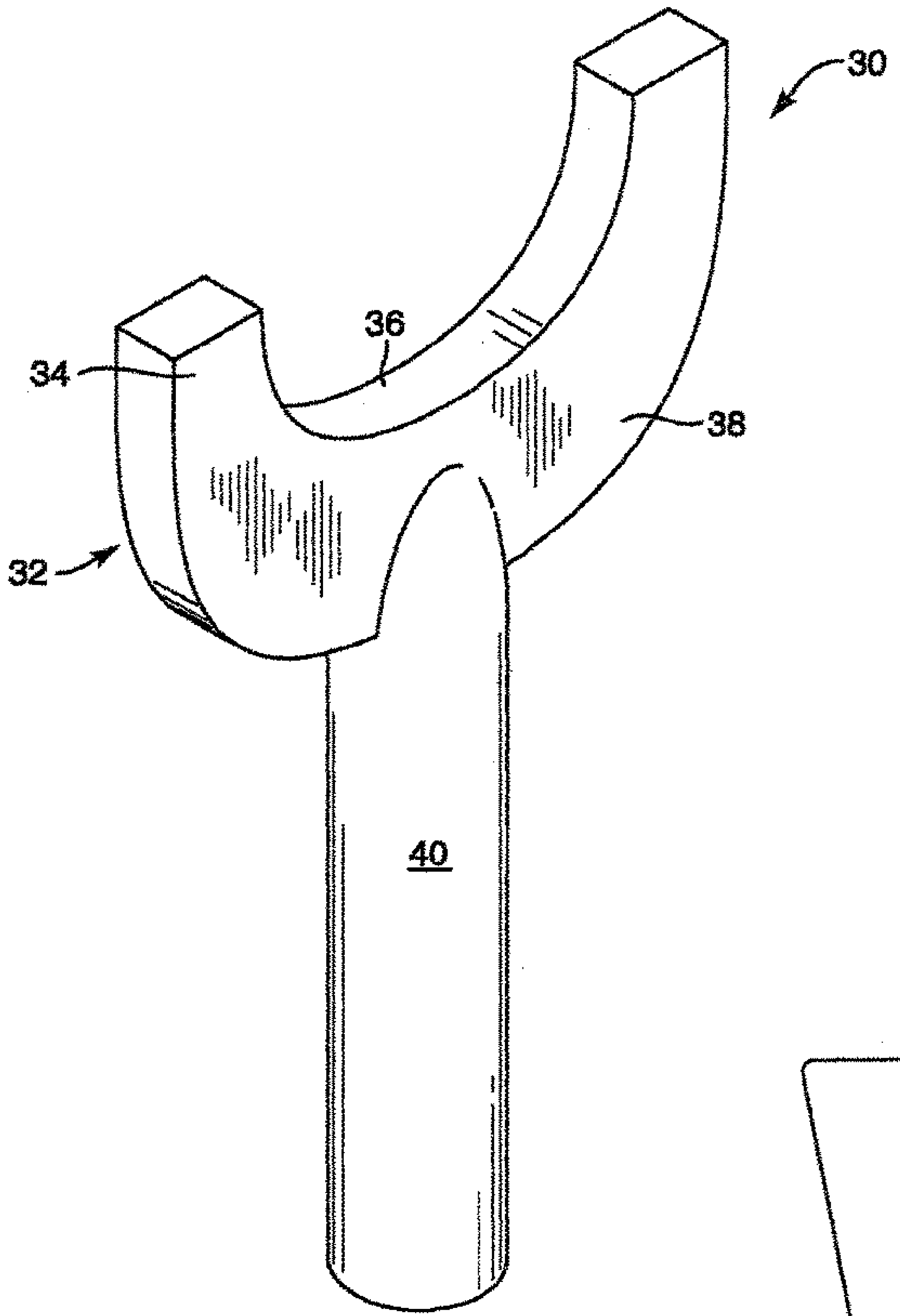
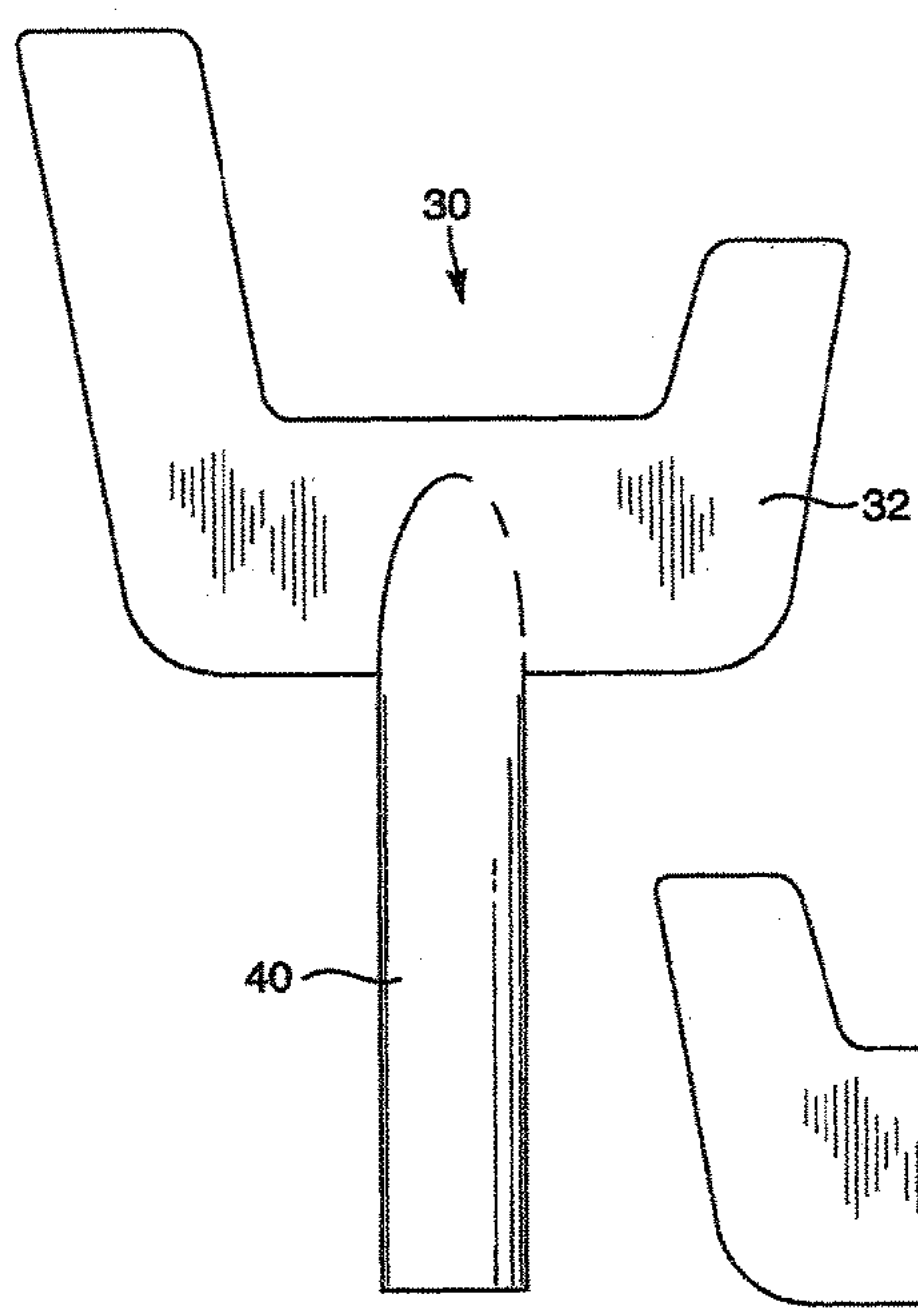


FIG. 8A



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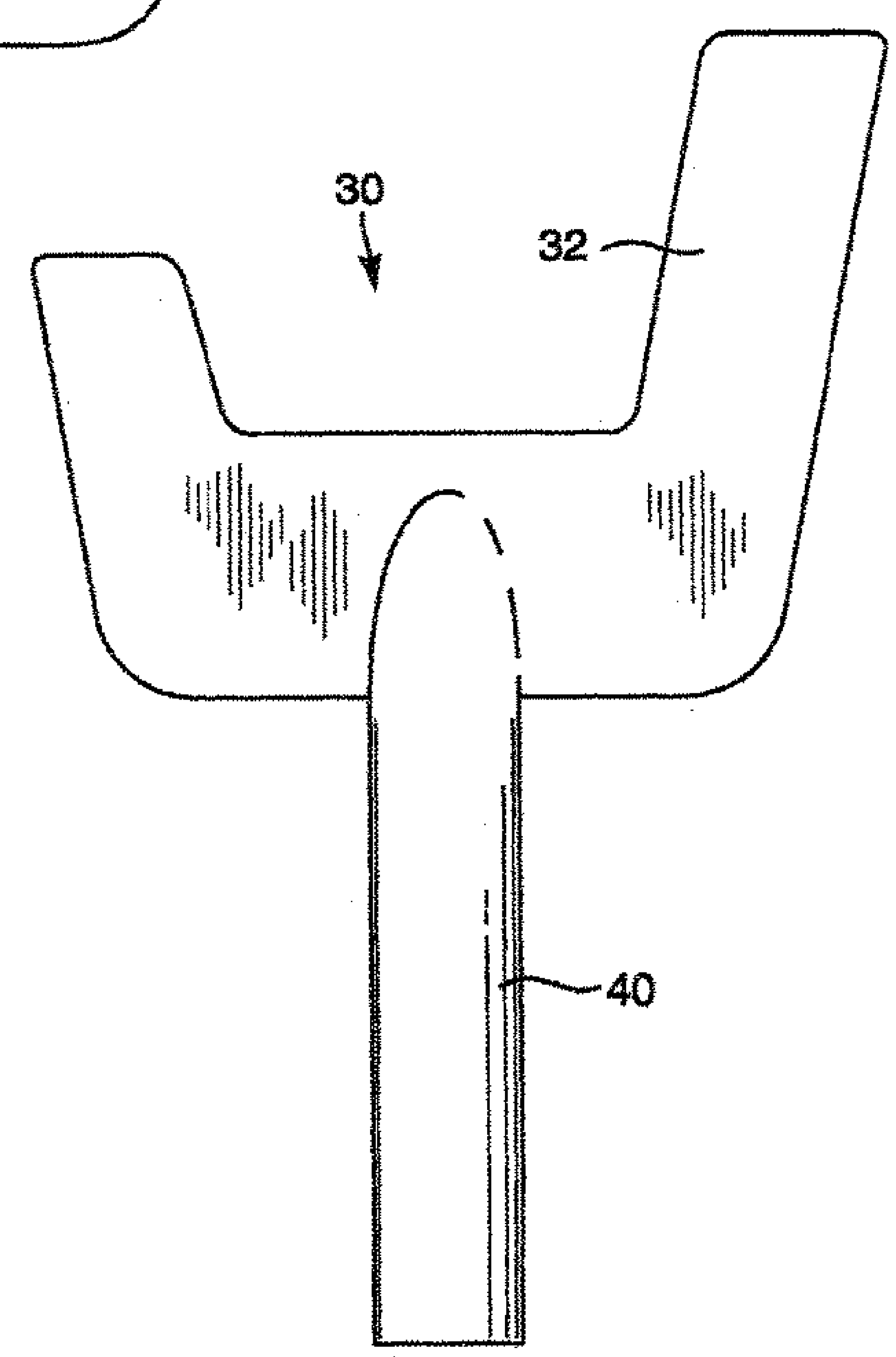


FIG. 8C

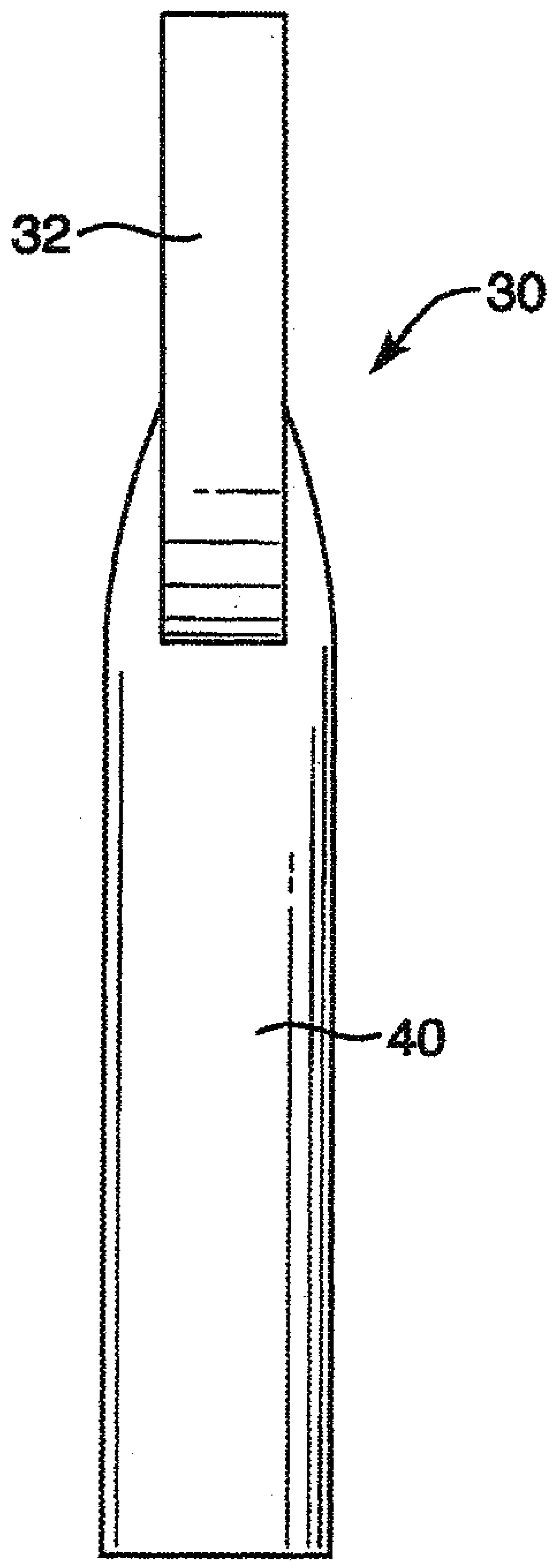


FIG. 8D

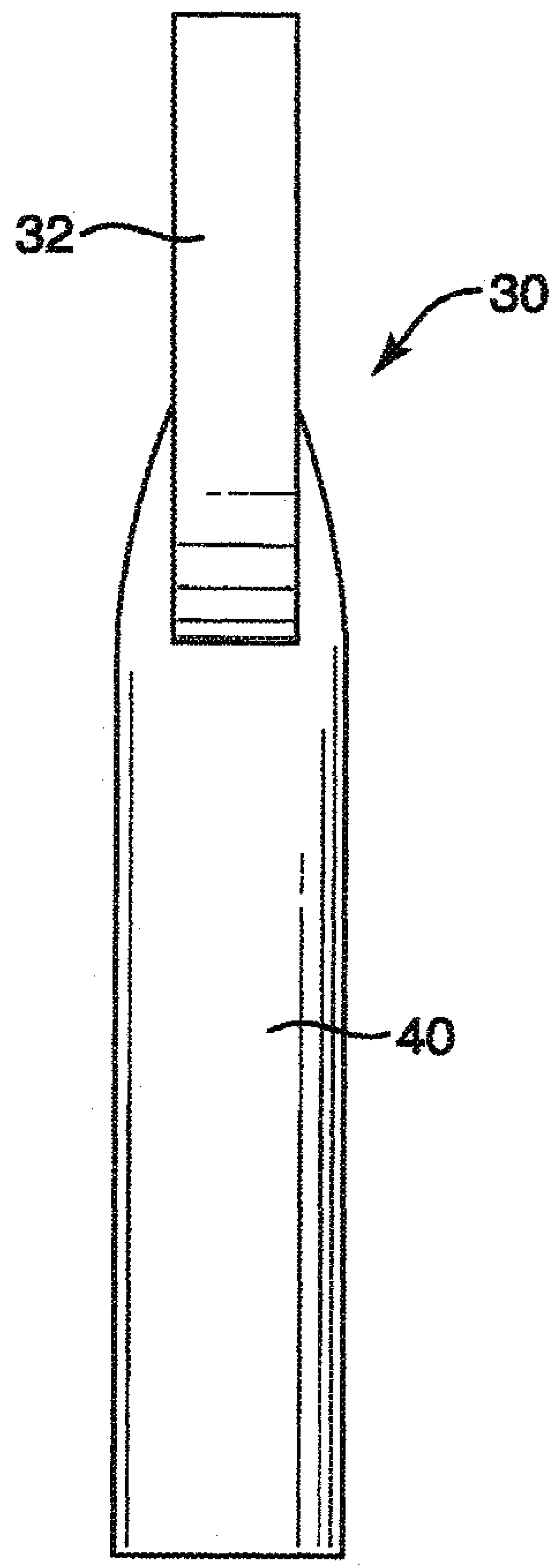
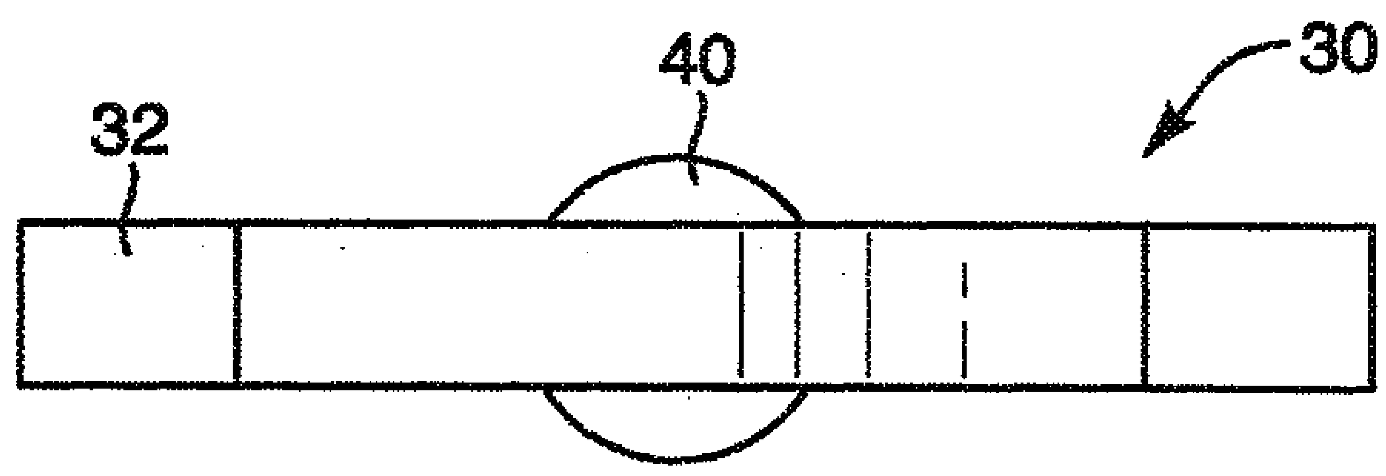


FIG. 8E



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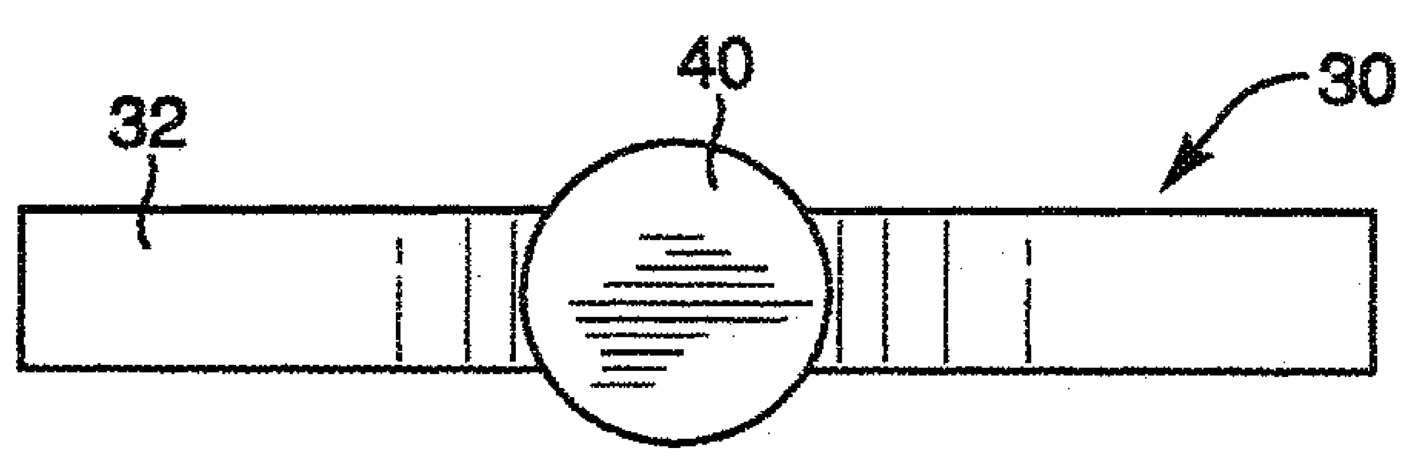

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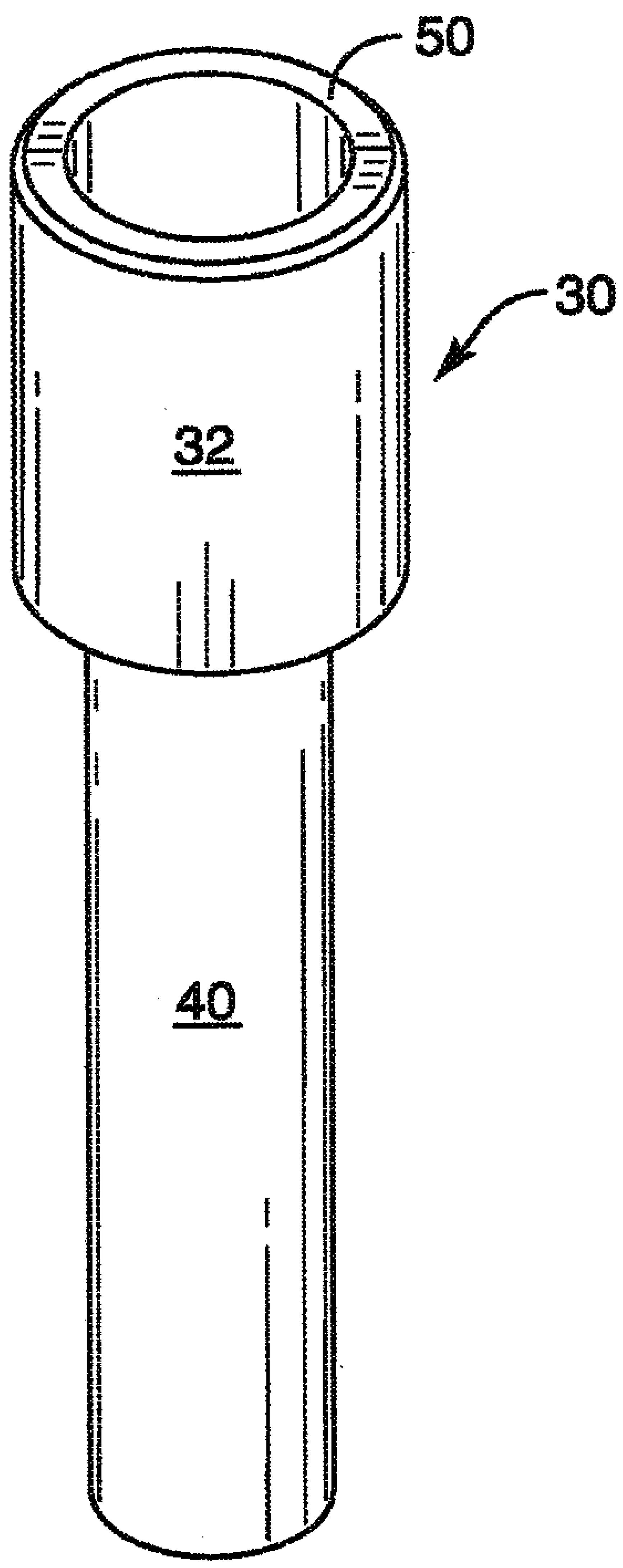

FIG. 9A

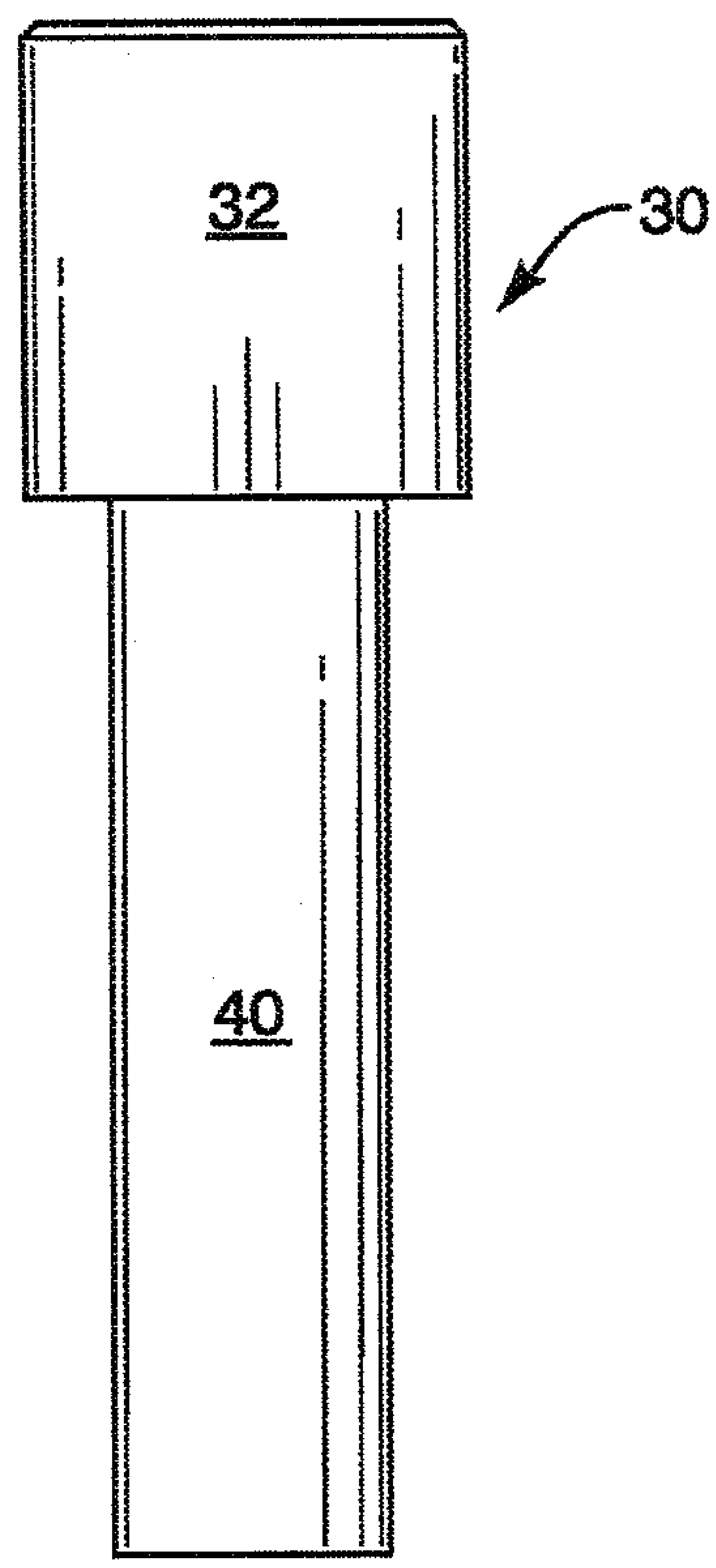

FIG. 9B

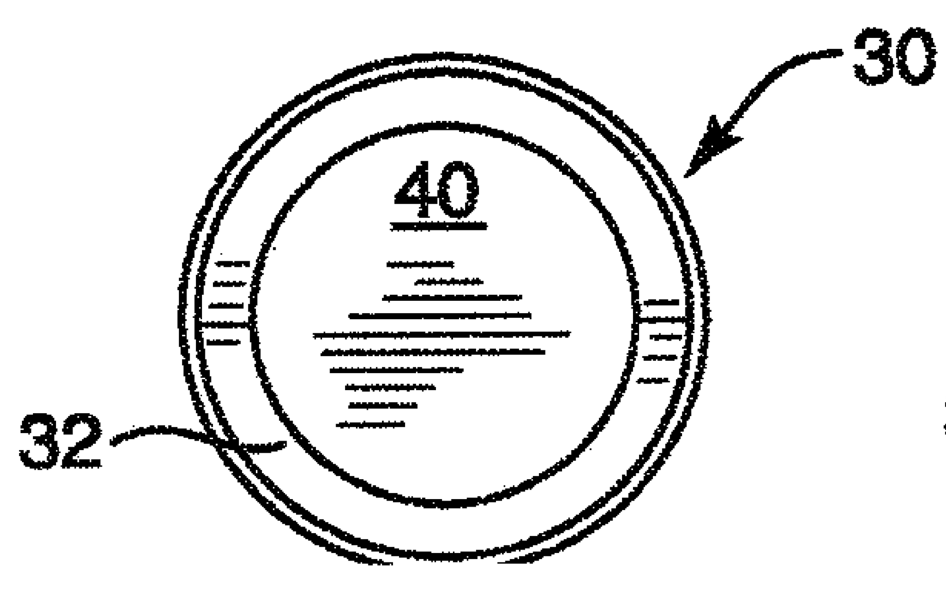

FIG. 9C

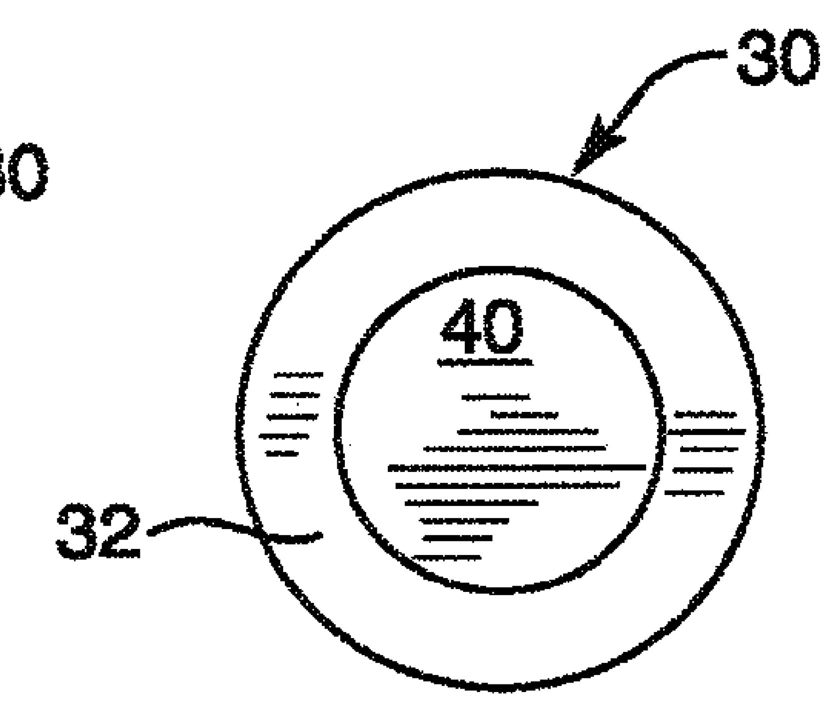

FIG. 9D

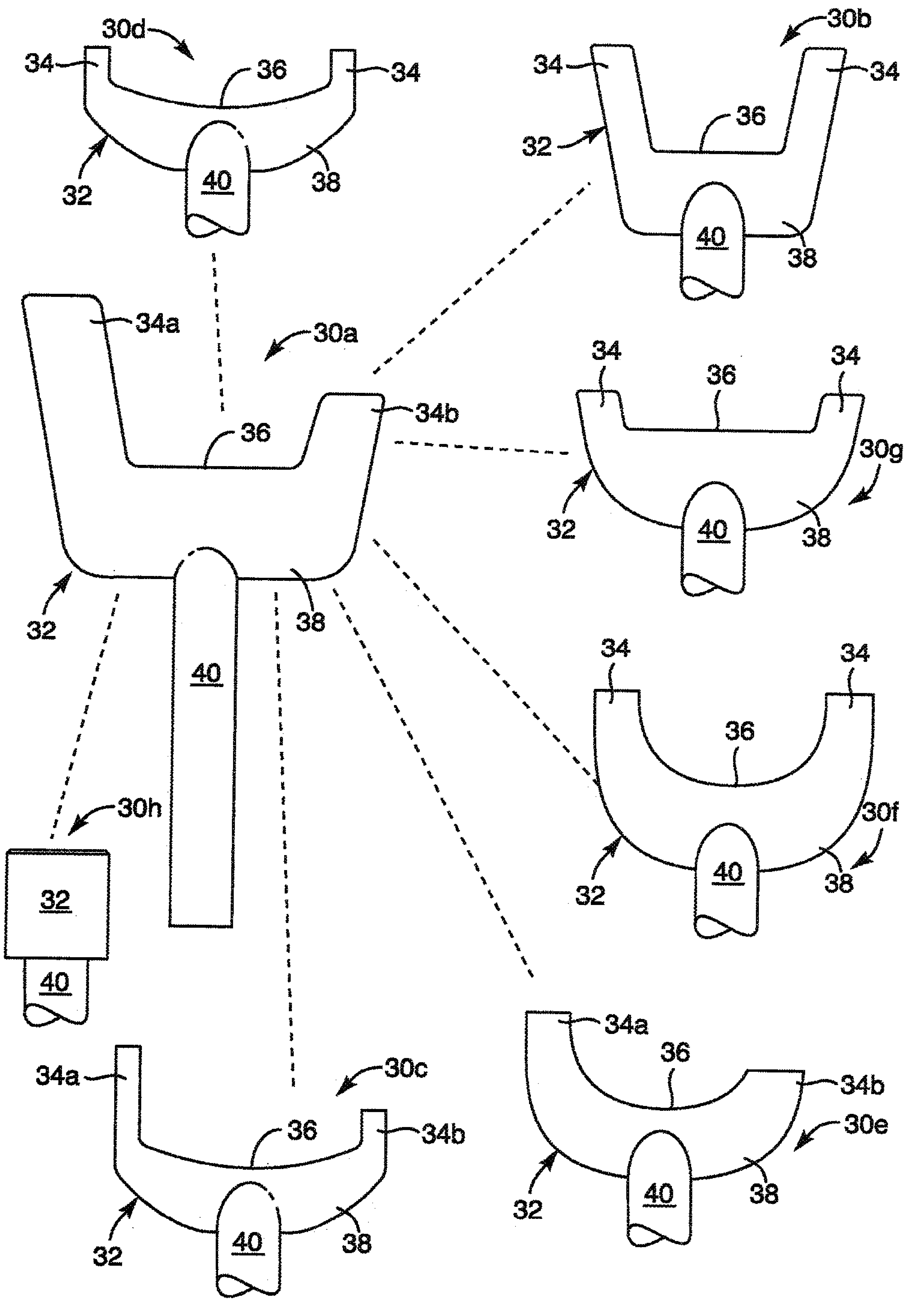
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FIG. 10A

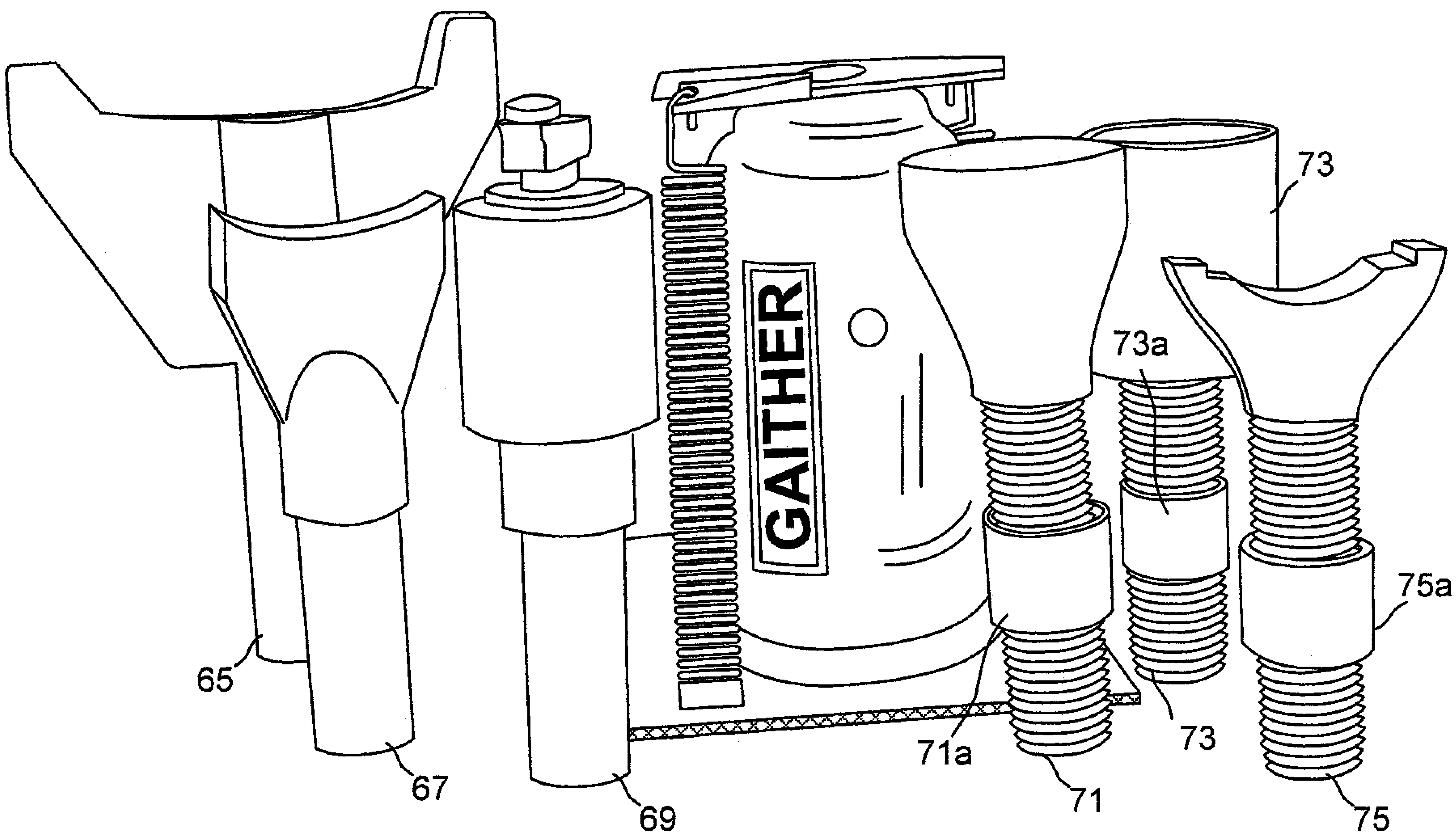
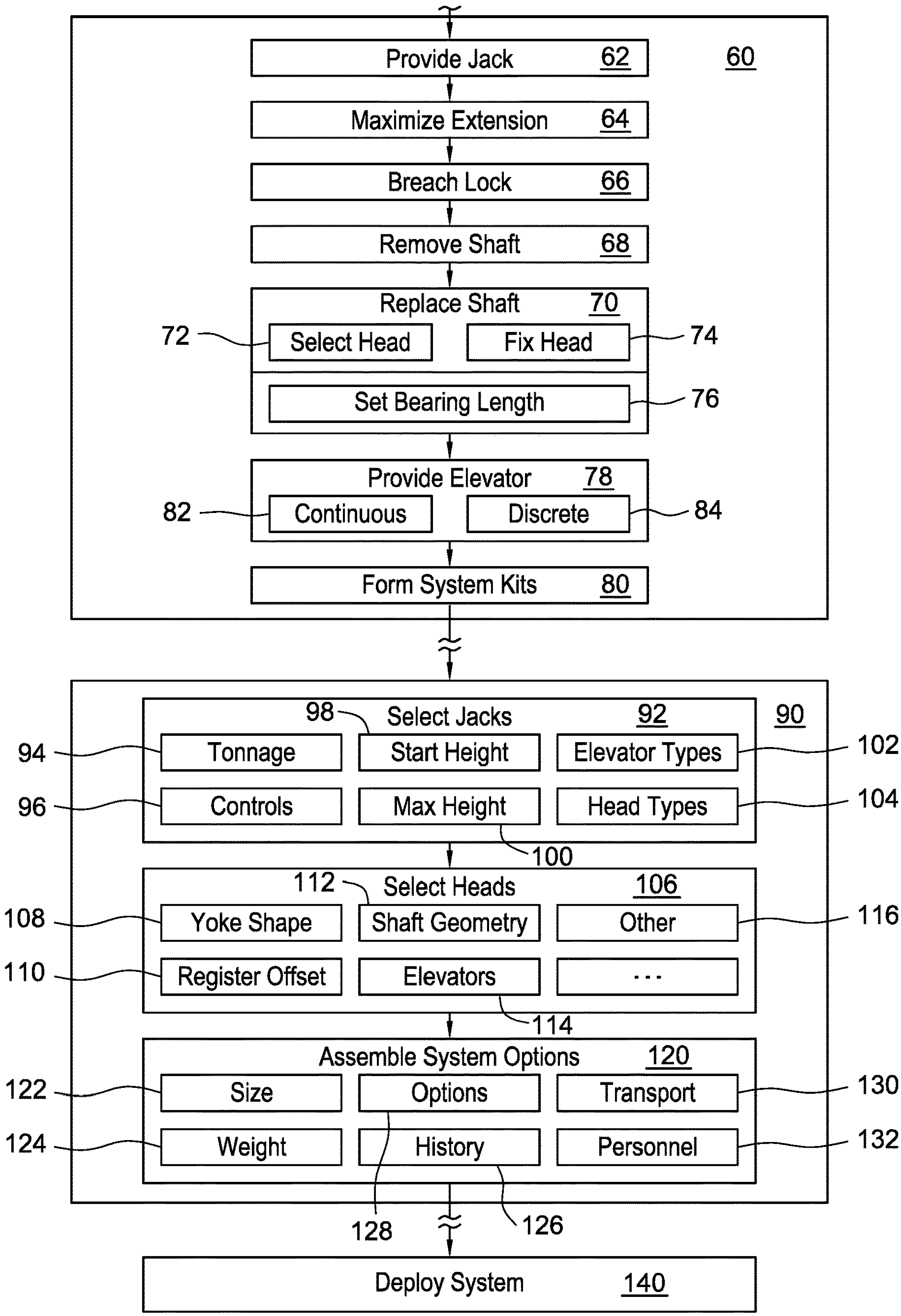


FIG. 10B


Provide Jack 62
60
Maximize Extension 64
Breach Lock 66
Remove Shaft 68
Replace Shaft 70
72
Select Head
Fix Head
74
Set Bearing Length
76
Provide Elevator 78
82
Continuous
Discrete
84
Form System Kits 80
98
Select Jacks 92
90
94
Tonnage
Start Height
Elevator Types
102
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Controls
Max Height
Head Types
104
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112
Select Heads 106
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Yoke Shape
Shaft Geometry
Other
116
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Register Offset
Elevators
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Assemble System Options 120
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Size
Options
Transport
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Weight
History
Personnel
132
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Deploy System 140

FIG. 11

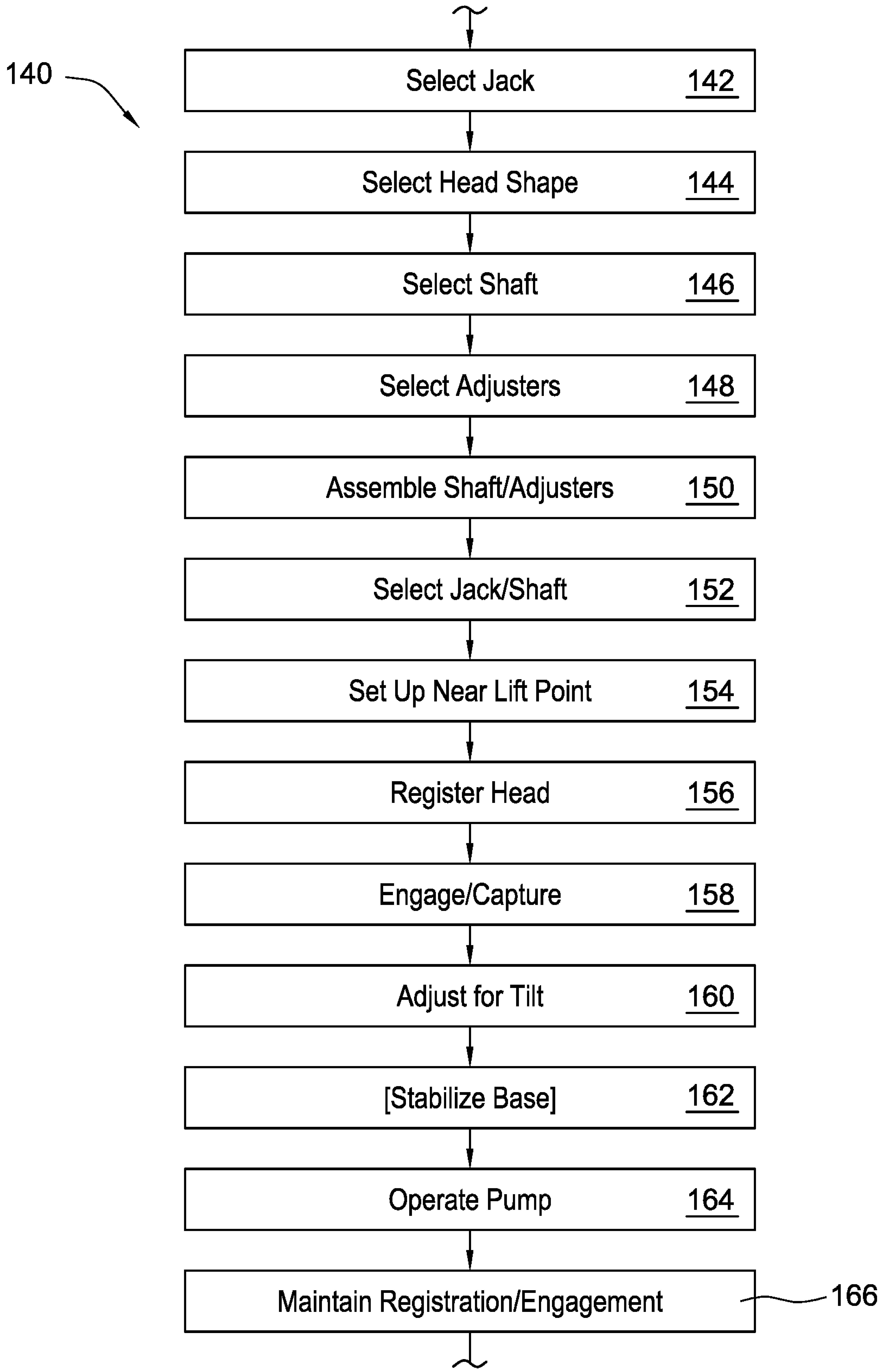
140
Select Jack 142
Select Head Shape 144
Select Shaft 146
Select Adjusters 148
Assemble Shaft/Adjusters 150
Select Jack/Shaft 152
Set Up Near Lift Point 154
Register Head 156
Engage/Capture 158
Adjust for Tilt 160
[Stabilize Base] 162
Operate Pump 164
Maintain Registration/Engagement
166

FIG. 12

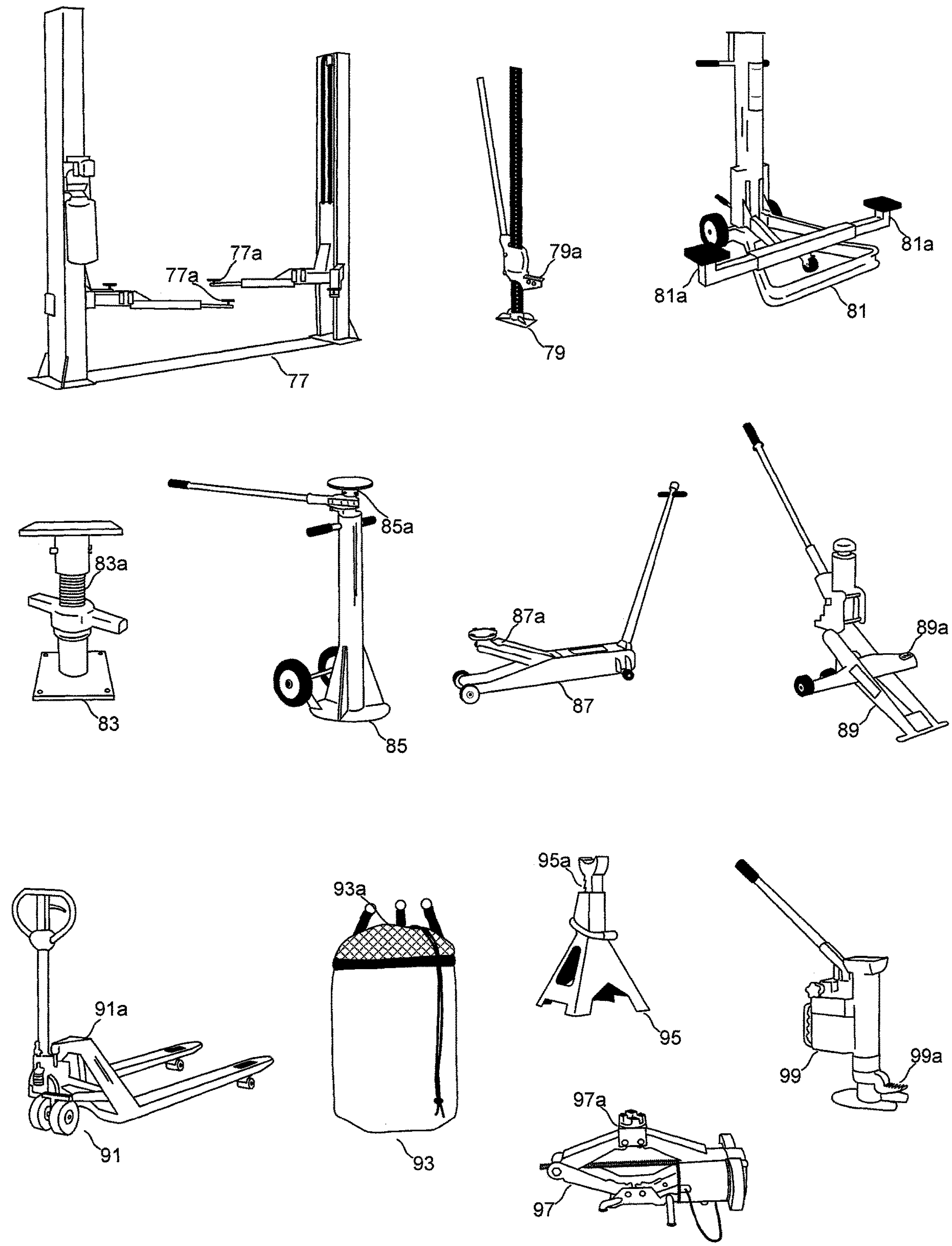
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FIG. 13

TILT-SAFE, HIGH-CAPACITY LIFT DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority from, and incorporates by reference in its entirety, U.S. patent application Ser. No. 15/260,167 filed Sep. 8, 2016.

BACKGROUND

Field of the Invention

This invention relates to hydraulic jacks and, more particularly, to novel systems and methods for hydraulic "bottle jacks" load rated for heavy vehicles under which they are used.

Description of Related Art

Bottle jacks are small, portable, self-contained systems. Relying on hydraulic oil, they operate on certain principles of fluid mechanics. Being hand-portable, they cannot have all the mechanisms, protections, conveniences, wheels, bearing widths or lengths, size, stabilization, visibility and so forth possible for rolling floor jacks (also called trolley jacks) common in commercial repair shops.

At the top of the piston is typically a head. That head is a problem. The relatively small cross sectional area of a head is almost universally inadequate. It is typically dictated by the size of the shaft inside the lift piston. Frictional engagement is poor due to metal-to-metal contact. Moreover, a bottle jack on or near a roadway has an uncontrolled supporting surface on which it may tip, slide, or otherwise shift dangerously. The instabilities of the head and the base against their respective environments combine to be dangerous.

For example, a bottle jack poorly placed or shifting during use creates a dangerous level of force and a weighty projectile. Forces may literally "kick out" a jack at a velocity and momentum (mass×velocity) sufficient to cause serious injury or death to a user in the vicinity

It would be an advance in the art to develop a system to stabilize a jack in the uncontrolled environment of roadside assistance. Novel and non-obvious improvements may benefit by sacrificing convenience of integral jacks for more useful and more readily adaptability on the roadside. Certain "consumer safety" benefits and restrictions may need to be set aside in favor of improved capabilities for a professional mechanic providing roadside assistance distant from the controlled environment of a workshop or garage.

BRIEF SUMMARY OF THE INVENTION

In view of the foregoing, in accordance with the invention as embodied and broadly described herein, a method and apparatus are disclosed in one embodiment of the present invention as including a bottle set in a base provided with a conventional hydraulic pump, hand lever, and release valve. However, the main lift piston may be modified to have no internal threads. In alternative embodiments, it may still keep internal threads. Air power may be substituted for hydraulics, used as an example here. Powered air or oil supplies may replace hand levers to drive pistons.

In certain embodiments, the shaft extending from the main lift piston may have a smooth wall sized to retro-fit within the already threaded inside diameter of a threaded main lift piston. The shaft in the piston may be fitted to a smooth inside wall of the main lift piston. In yet another embodiment, the shaft may not match piston threads yet still be threaded and engaging a collar nut at the top of the piston rather than the threaded interior of the main lift piston. Some features may be used with conventional shafts threaded into conventional pistons.

Multiple heads, sometimes called lifting heads, each formed integrally and in fixed, solid relation to their shafts may be provided in a set of exchangeable accessories. Heads may include a conventional round head, with its conventional crossed grooves. However, in an accessory in accordance with the invention, the entire shaft is typically removable from within the lift piston. In this way, other alternative accessories may be placed into the main lift piston to replace the original head and shaft.

Integration results in bottle jacks that are self contained. The pump is typically built right into the base, or at least its principal cylinder for its piston is. The other components are fitted therein and thereagainst. The bottle contains the main cylinder, the oil, and the main lift piston. That lift piston fits inside the bottle and the cylinder. The lever may be a separate article, but may simply be a tire iron that is a standard lug wrench used also to operate as a lever. Thus, outside of the lever, the packaging is very compact and self contained. The release for a bottle jack may be a valve formed in a cavity built into the casting of the base. That valve, by a simple turning may be opened a selected amount to allow oil to escape from the main lift cylinder beneath the main lift piston, thus providing a steady descent of the lift piston. Accordingly, the user does not have to deal with large forces. A comparatively modest rate of lift is available and a controlled, modest rate of descent is provided.

For bottle jacks used in accordance with the invention, the jack height and the distance between the ground or other supporting surface below the jack and the component being lifted (at its lifting point or location over the head) will often not match very closely. Blocks or shims may be placed under a jack. Sections of wooden boards may serve as shims. In addition, a central shaft on which the head is mounted may or may not be threaded on its outside surface. A thread may or may not be formed on the inside surface of the cylinder to receive the shaft threads.

A user may shim up the base of a jack with boards or blocks, of constant thickness or tapered to some safe (presumably) height. An operator or user may turn the head its shaft or with a shaft (if fixed thereto). The shaft may extend within the main piston in order to adjust the head up to a position of contact. Contact must be made with a lift point (location) on the component (e.g., a spring. "U" bolt, bracket axle, etc.) against which the force will be applied so the load will be lifted. The process of lifting the jack on its supporting blocking and extending the shaft under the head within the lift piston provides flexibility in the starting height of a bottle jack. Thus, the entire stroke of extension of the principal piston is available for lifting.

In certain embodiments, a new head may have a shape that provides a yoke having a flat or curved bottom, main lifting surface. At either end in a horizontal direction along that main lifting surface may be a restraint or retainer. The retainer may appear like a leg of a U. The head is shaped something like a U with the main lift surface providing the base of the U and the retainers or legs of the U rising upward away therefrom. The main lift surface is sized to fit various components, such as an axle, a spring leaf, or the like.

The legs of the U may be of different lengths. For example, one side may extend higher than the other (e.g., one end of the head may have a leg or a retainer that extends higher than that of the other end). This will permit lifting or extending the shaft a distance or height before moving the jack under the component to which lift forces will be applied. By having one leg higher, the lower and leading leg or retainer may pass under the lifted component. The trailing leg or retainer extends higher and therefore will not past under, but registers against the lifted component. This brings the jack to a stop, and into registration for proper lifting.

The shaft under such a head may be threaded or smooth. If smooth, the shaft may be provided with shims or risers. A user may withdraw the shaft from within the main lift piston, slide one or more shims or risers onto the shaft, and drop the shaft back into the lift piston. This permits setting a lift height bias or height offset or starting height at an arbitrary distance desired and appropriate for the lifted object.

A system of risers may include risers having a nominal height of one unit, two units, and four units. A unit may be a centimeter, an inch, or some other appropriate height. Thus, the head height with respect to the main bottle and base of the jack may be offset by one inch (unit of height) with a single riser, two units by a two-units-of-height riser. Three units require a combination of the one unit and two unit risers. Four units require the use of a four-unit-high riser. Five units require a combination of the four and one unit risers. Six units require a combination of the four unit and two unit risers. And seven units require a combination of the one, two, and three unit risers.

Such a kit of accessories may be placed in a case. They would not work conveniently if integrated to always be connected. Their modularity dictates that they cannot all be installed as part of the jack at all times. A redesign of the method of use and the architecture of the jack are in order to comply with the needs addressed by a system in accordance with the invention.

In an alternative embodiment, the inner surface of the main lift piston may be threaded and the outer surface of the shaft may be threaded. The head in accordance with the invention may be rotated to rotate the shaft, thus causing relative displacement of the mating threads between the shaft and the piston.

However, in another alternative embodiment, the shaft may be still threaded, but smaller in diameter such as to not mate with the threads of the piston. It may fit within a smooth wall of a piston. An advantage to a shaft having threads is that another shim or riser may simply be a set ring. A set ring may match the threads of the shaft, and be threaded upward or downward in order to provide a preset displacement of the shaft with respect to the piston.

The height of the shaft within the main lift piston need have nothing to do with an engagement of threads between the shaft and the piston. Rather, the offset distance is controlled by the position of the set ring threaded down along the threads of the shaft, and engaging the top surface or annulus of the main lift piston. One may see where mutual threads between the shaft and piston, smooth shaft and threaded piston, threaded shaft and disengaged threaded piston, smooth shaft in threaded piston, or smooth shaft in smooth piston are all combinations that may be configured to work in accordance with the invention.

Moreover, the head shapes may vary. For example, in one embodiment, the shape of the yoke that becomes a head in accordance with the invention may have a circular internal diameter or simply a curved inside lift surface. The lift surface may extend from the tip of the retainer or leg on one end to the tip of the retainer on the other end in a smooth arcuate curve. The curve may be circular, some other curve shape, or the like. This tends to center any load near the bottom most region of the curve, but may accommodate shallower curves than circular, or the like.

In yet another embodiment of an apparatus and method in accordance with the invention, the head may be constituted by an annulus extending some height, typically sufficient height to accommodate an open end of a "U" bolt. For example, a shaft of any of the varieties described hereinabove may be formed integrally with a head that is a right circular cylinder, hollow in the center. The upper edge or annulus of this cylinder may press against the nut attached to "U" bolt. The hollowed cavity within this tubular shape is sized to receive the free end of the "U" bolt extending out beyond the nut.

In an apparatus and method in accordance with the invention, a heavy load may be lifted in a Y-shaped yoke or in a "cup" type of cylindrical head. These may be adjusted by threading between a shaft and lift piston. Threading may adjust between a set ring and a threaded shaft fitted into an inner cavity of a main lift piston. Initial height may be offset or set by an assembly of risers arranged in combination to provide an initial offset in the relative height between the head and the main bottle jack.

Conventional blocks (or even wedge-shaped shims) may still be used under the jack. Thus, the system and apparatus in accordance with the invention may be used by retrofitting shafts and heads in accordance with the invention into conventional jacks from which the main shaft has been removed. Meanwhile, a jack may actually be fabricated in accordance with the invention as an entirely new system.

One embodiment of an apparatus may include a base, a containment vessel sealed to the base, a cylinder within the containment vessel, a piston operably engaging the cylinder to move with respect thereto in response to hydraulic pressure, a pump connected between the cylinder and the containment vessel, a system of valves controlling movement of a hydraulic fluid between the containment vessel, the pump, and the cylinder, and a shaft fitted to ride within the piston and selectively removable therefrom without tools. To this may be added or included a head monolithically formed with the shaft to engage a load, the head comprising a lift surface and a retainer, and at least one retainer being disposed horizontally at one extreme dimension of the head to resist lateral movement of the lifted load with respect to the head. The shaft may have an outer surface that is smooth, engaging the piston exclusively for the purpose of horizontal stability, and transferring substantially no vertical force between the smooth wall and the piston.

A set of risers or spacers may be sized to fit against the smooth wall of the shaft to offset vertically the shaft with respect to the piston, and may be sized to have heights that are substantially integral multiples of one another. The head may be constituted by a yoke generally shaped like a 'U' and having two legs extending above a lift surface, which may be flat, curved, cupped, or otherwise shaped. The yoke typically comprises two legs, disposed horizontally opposite one another with respect to the lift surface, one leg being significantly shorter than the other leg. Equal leg lengths may also be used. The shaft and head (principally including the yoke) are integrally formed and sized to fit the shaft within a bottle jack conventionally manufactured, and altered only by removal of a threaded shaft originally manufactured as a part of the jack. A shoulder, on at least one of the shaft and a head integrally formed with the shaft, is sized and shaped to fit against an annular top surface of the main lift piston. In at least some embodiments the load path of force supported by the piston does not pass through the shaft at any point substantially below the shoulder.

A method of lifting a load may begin by providing a bottle jack and a head, the head comprising a yoke integrally secured to a shaft, the shaft being selectively removable without tools from within a piston of the bottle jack, selecting a head, placing the head within the piston, placing the bottle jack beneath the load, registering the yoke under a lift point, and lifting the load may be reversed by conventionally by descending the load, and removing the head from the bottle jack. A set or kit on a service truck may include multiple heads configured to have yokes of different shapes corresponding to lift points on a load to be lifted. The multiple heads may have shapes selected from a 'U' shape having a flat base and legs extending thereabove, a 'U' shape having a continuous surface between opposite extremes of the yoke, a yoke constituted by a cup-shape having a top, annular, lift surface, surrounding a relief region for receiving an unloaded portion of a lifted component, or the like. In one method, a mechanic may obtain a conventional bottle jack, and remove a central shaft from a main lift piston thereof. By fitting a head, comprising a yoke integrally and monolithically formed within a shaft to fit the shaft within the main lift piston and the yoke sized to not enter within the piston, the mechanic (user, operator) is also providing a lift surface against which the main lift piston will pass load to the lifted object. Also, remove one may, but need not from inside the main lift piston the set of threads. The yoke should be integrally formed on a shaft to operate as a single, solid, monolithic component, the shaft being sized to fit within the main lift piston snugly but easily movable whether or not threads remain.

One method of manufacturing a jack may include providing a frame sealed to a containment vessel, providing a pump operably connected between the base and the containment vessel, providing a cylinder within the containment vessel, providing a piston operably coupled to travel within the cylinder, operably connecting a system of valves to selectively pass a hydraulic fluid from the containment vessel through the pump to the cylinder at a pressure effective to lift a load supported by the cylinder and to release the hydraulic fluid to pass from the cylinder back to the containment vessel in order to effect retraction of the main piston under the load, and providing a head constituting a yoke secured to a shaft, the shaft sized to selectively install within the piston and remove therefrom without the use of tools. The yoke may be selected to be shaped as one of 'U,' a cup, or a flat. The system may include a set of risers (spacers, adjusters, shims, collars) usable in combination to offset the yoke from the piston prior to extension of the piston.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing features of the present invention will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only typical embodiments of the invention and are, therefore, not to be considered limiting of its scope, the invention will be described with additional specificity and detail through use of the accompanying drawings in which:

FIG. **1** is a perspective view of one embodiment of a bottle jack equipped with safety accessories in accordance with the invention;

FIG. **2** is a perspective view of the system of FIG. **1** illustrating in side elevation profile views various alternative embodiments of various head systems identifying yokes, shafts, and risers in accordance with the invention;

FIG. **3** is a side elevation view of one embodiment of a bottle jack including a threaded head cavity and threaded shaft in accordance with the invention;

FIG. **4**A is a side elevation view of an embodiment of a bottle jack system including a smooth head cavity and smooth shaft in the principal lift piston;

FIG. **4**B is a cutaway view of a piston wall with an O-ring embedded and a cutaway piston wall with a mechanical keeper, according to various embodiments.

FIG. **5**A is a side elevation view of an alternative embodiment of a bottle jack system having a non-engaging, threaded shaft that does not engage threads inside the lift piston of the bottle jack, regardless of whether they exist there, but which relies on an optional adjusting nut traversing up and down the threaded shaft to provide an initial offset of the head with respect to the piston;

FIG. **6** is a side elevation view of a system of risers or shims adapted to fit over the shaft associated with the head of a bottle jack, and thus provide an initial displacement or offset of the shaft and yoke above the top of the main lift piston:

FIG. **7**A is a perspective view of one alternative embodiment for a head system having a trapezoidal yoke on a shaft integrated therewith;

FIG. **7**B is a front elevation view thereof;

FIG. **7**C is a rear elevation view thereof,

FIG. **7**D is a left side elevation view thereof:

FIG. **7**E is a right side elevation view thereof;

FIG. **7**F is a top plan view thereof;

FIG. **7**G is a bottom plan view thereof:

FIG. **8**A is a perspective view of an alternative embodiment of a head system having a curved yoke integrated with a vertical shaft;

FIG. **8**B is a front elevation view thereof;

FIG. **8**C is a rear elevation view thereof;

FIG. **8**D is a left side elevation view thereof;

FIG. **8**E is a right side elevation view thereof;

FIG. **8**F is a top plan view thereof;

FIG. **8**G is a bottom plan view thereof;

FIG. **9**A is a perspective view of an alternative embodiment of a head system for a bottle jack in accordance with the invention having a cup or cylinder shape for a yoke integrated with a shaft;

FIG. **9**B is a front elevation view thereof, the rear elevation view, the left side elevation view, and the right side elevation view all being identical thereto;

FIG. **9**C is a top plan view thereof:

FIG. **9**D is a bottom plan view thereof;

FIG. **10**A is a side elevation view of one embodiment of a head system having various shapes for the yoke portion integrated to a shaft portion of an accessory for use in a bottle jack in accordance with the invention:

FIG. **10**B depicts six implementations of lifting heads according to various embodiments;

FIG. **11** is a schematic block diagram of a process for manufacturing a bottle jack in accordance with the invention, including an optional retrofit embodiment, as well as a process for outfitting a service truck or other operation; and

FIG. **12** is a schematic block diagram of one embodiment of a method for using a bottle jack in accordance with the invention.

FIG. **13** depicts a number of different types of lifting devices suitable for use with the various embodiments.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

It will be readily understood that the components of the present invention, as generally described and illustrated in the drawings herein, could be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of the embodiments of the system and method of the present invention, as represented in the drawings, is not intended to limit the scope of the invention, as claimed, but is merely representative of various embodiments of the invention. The illustrated embodiments of the invention will be best understood by reference to the drawings, wherein like parts are designated by like numerals throughout. A reference numeral followed by a letter is simply an instance of the item identified by the number. It is proper herein to use the reference number alone or with a trailing letter, and every trailing letter need not be referenced in the text, even if appearing in a figure.

The various embodiments are described in terms of being used with bottle jacks, for the sake of clarity and brevity. However, the various embodiments may be used with other types of lifting devices, including for example, a bottle jack, a multiple post vehicle lift (e.g., a two post vehicle lift, a four post vehicle lift, etc.), a farm jack, a bumper jack, a screw jack, a trailer jack, a floor jack (sometimes called a garage jack or a service jack, e.g., with rollers), a forklift jack, a pallet jack, a lift bag lifting device, an electric jack, jack stands, and a toe jack, and other like types of lifting devices known to those of ordinary skill in the art. The various lifting devices may be powered by one or more of hydraulic fluid, by compressed air or other gases, by a mechanical lever operated by a user, by an electric motor, or other sources of power or forces.

Referring to FIGS. **1**-**12**, systems **10** in accordance with the invention must avoid or overcome several problems. At one level, they operate on certain well known principles of fluid mechanics. For example, a bottle jack **11** in accordance with the invention typically contains a base **12** formed by casting or forging the base and fitting and sealing into it a containment vessel, the bottle **14**. A small manual pump **18** is typically formed by fitting a piston **20** into a cylinder **16** machined into the casting **12** that is the base **12**. Air-powered jacks **11** may be adapted to receive compressed air. The base **12**, at its widest dimension, is typically approximately twice as wide as the containment vessel **14**. Some implementations may call for increased stability due to vibrations, horizontal forces or unlevel surfaces. In such implementations embodiments are provided with a the base **12** may be up to four times as wide as the containment vessel **14**, or even up to ten times as wide as the containment vessel **14** or more.

The piston pump **18**, along with an associated assembly of valving, such as check valves. It pumps oil from the main containment vessel **14** or bottle **14** into a central cylinder **16** that runs along the axial center of the bottle **14**. In that central cylinder **16** may be a piston **20** constituted by a movable, cylindrical member fitted with a seal near the bottom thereof that seals against oil leakage out from the region between the seal on the piston **20** and the containing cylinder **16**.

In operation, a hand lever **24** is pumped by a user resulting in a leverage advantage on the pump cylinder **29**. The pump piston **28**, as it pumps up and down within the pump cylinder **29**, pumps oil from within the bottle **14** or containment vessel **14** into the main cylinder **16** beneath the main piston **20** or lift piston **20**. The result is hydraulic pressure lifting the main piston **20**. A system of check valves prevents any backflow from under the piston **20** toward the pump **18**.

At the top of the piston **20**, and fitted into it, is typically a head **30**, sometimes called a lifting head. That head **30** is specially designed to avoid a traditional problem. A typical conventional head is a machined part that is usually a circular piece having a suitable thickness on the order of about one centimeter thick or more depending on the rating (load capacity) of the bottle jack **11**. Typically that head has formed in it a cross of two grooves orthogonal to one another, or some other texturized shape cut into the head.

The top surface of that head, such as the cross of two grooves orthogonally oriented with respect to one another on the top of that head, in typical conventional systems, constitutes the entire gripping capacity of the head to support any component being lifted. Notwithstanding there exists some amount of friction between the top head surface and a matching surface on a component against which the head lifts, the only lateral force other than plain frictional resistance against sliding between the component and the head is that cross of twin grooves or other teeth or texturing provided on the head.

The result of the small cross sectional area of a head is inadequate. Frictional engagement is poor due to the fact that it is formed of a metal such as steel. Also, the components against which the jack fits may not be flat, may not be level, or both. Moreover, they may move, change their orientation, or both while being lifted. All these are a danger.

It is not uncommon to have a vehicle, machine, article, or other load weighing hundreds, thousands, or even tens of thousands of pounds. For example, the gross vehicle weight rating on large over-the-road trucks may reach 80,000 pounds, or 40 tons. A significant fraction of that load is supported by each axle, and a portion of each axle is supported by each set of wheels on that axle.

A flat tire or damaged component may require halting a truck, placing a bottle jack on the ground, roadway, or other surface thereunder, and lifting a set of wheels. Of course, the wheels cannot be accessed directly. Accordingly, one end of the axle must be lifted.

Some typical locations available as possible lift points may be a portion of the axle, which may be round, rounded, or rectangular, thus presenting a rounded, circular, or flat surface. Also, a truck may be lifted by a lifting spring. Although not recommended, because it can damage the threads, a jack may lift against "U" bolt securing an axle to its spring assembly.

"U" bolts typically extend over a set of springs, with the base of the "U" with each leg of the "U" extending downward to capture each leaf of the spring assembly. A bracket typically secures below an axle, by the "U" bolts passing through the bracket. A nut on each free end of the "U" bolt secures the bracket plate to the "U" bolt. Thus, the axle is captured between the bracket and the springs by the "U" bolt.

A bottle jack poorly placed or shifting during use creates a danger. Suspension systems often move an axle in an arc, such that the lift point above a jack moves as it rises. An engagement that shifts or is shifted at its base along a supporting surface may be important. An engagement that keeps a lift point engaged with the jack, regardless would be valuable. An engagement forceful enough to preferentially keep the head engaged even if the base must slide or even tip may also be valuable.

A flying jack results when eccentric forces may literally "kick out" a jack when friction fails to keep the base fixed or the head of the jack secured with respect to the lift point on the component against which the jack is applying force to lift.

The energy released is sufficient to cause serious injury or death if the jack strikes a user who is in the vicinity or operating the jack. Moreover, the jacks may be damaged and many jacks show damage to the head from such slips and falls.

The substantial loading on a jack with the ground supporting the base of the jack, and a substantial load on top of the jack, particularly when loading (force and location) on the base or on the head becomes displaced off a central axis of the lifting shaft.

The problem is not trivial. Besides alignment, a dynamic problem with bottle jacks is that as an axle lifts, it does not lift exactly vertically. A swinging or radius of motion may exist, causing an axle or other lift point to swing out of alignment. This may be laterally (left or right), longitudinally (forward or backward), as well as upward on a radius. Any combination thereof may also occur.

This effect will mean that as a truck lifts, the position of the lift point over the jack changes. It moves in an arc centered on the contact point of the radius, such as a swing arm or other pivot about which a lift point may move. This may be one end of a spring shackle, an arm, a tandem axle connector, an opposite tire that remains grounded, or the like.

The problem does not exist with steel leaf or coil spring systems alone. Air bag types of springs have similar problems, and typically are coupled on even shorter swing arms causing a greater arcuate displacement. Any of the foregoing may result in shifting a load or even tipping a bottle jack, off its original vertical axis. Meanwhile, this occurs as the main piston extends from the bottle jack, lengthening the distance from a supporting surface (e.g., ground, pavement, roadway, roadside, etc.) as the axle lifts to raise a tire for changing.

Accordingly, a system is described hereinbelow to stabilize a jack and keep it in its proper location. It provides lateral, longitudinal, or both forces in its engagement between a head of a bottle jack and the component against which the bottle jack will operate or lift, and be urged horizontally as well.

It still provides the leverage, still maintains a comparatively compact size and envelope (set of outer dimensions), and is a compact kit. Maintaining such a system as a self contained, always integral unit may not be realistic. Adaptability often sacrifices integral connection of components.

Thus, it is one of the novel and non-obvious improvements to develop a system that sacrifices convenience of integral jacks for adaptability in the hands of a professional. For example, extension of the shaft directly supporting the head is an advantage. Moreover, providing the foregoing systems in a compact format, easily carried in a vehicle remote from a garage, such as a service vehicle is valuable. Such a system best serves, as it can be handled easily, often with a single hand, by an individual technician (mechanic) sent out to assist a disabled truck right at the highway side.

Referring to FIG. **1**, while referring generally to FIGS. **1** through **12**, a system **10** and method in accordance with the invention may involve a bottle jack **11**. A bottle jack **11** may actually form a significant portion of the operating mechanism of the system **10**. In certain illustrated embodiments, the bottle jack **11** may be completely conventional. In other embodiments, the bottle jack **11** may actually be newly manufactured to include different components and material properties than conventional bottle jacks **11**. Meanwhile, a system **10** in accordance with the invention may operate to improve function and safety of a bottle jack **11**, as described hereinabove.

The bottle jack **11** may include a base **12**, typically formed by casting or forging, followed by machining to receive certain other components. For example, the base **12** may be machined inside a receiver portion **13** to receive a bottle **14** that constitutes an outer wall **14** or containment vessel **14** holding hydraulic oil.

The bottle **14** may be threadedly engaged, maintained by some other compressive force, clamped, or otherwise engaged with a cylinder **16** operating near the center of the bottle **14**. Together, the bottle **14** and the cylinder **16** form an enclosed chamber. Of course, the receiver **13** of the base **12** secures the sealing of the bottle **14** and cylinder **16** against the base **12**. The cylinder **16** and the bottle **14** in which it is disposed operate as fluid containers.

The bottle **14** actually maintains a comparatively low pressure, in fact, it need not support much greater than atmospheric pressure on a hot day. In contrast, the cylinder **16** will support hydraulic pressures of pumping, and will be the containment vessel **16** that entirely contains the pressurized supply of oil that actually will lift or be the main lifting element of the system **10**.

In order to pressurize the cylinder **16**, or the inside cavity thereof, a pump **18** may operate. A valve **19** alternately closes to permit flow from the pump **18** into the cylinder **16**. It opens to provide relief of pressure out of the cylinder **16**, passing oil from the cylinder **16** back into the bottle **14**. Meanwhile, the pump **18** pumps oil out of the bottle **14** and into the cylinder **16**, by increasing the pressure of the oil and lifting a piston **20**.

The pump **18** is controlled in a certain context by the valve **19**. In practice, if the valve **19** is opened into a first mode by an actuator **21**, then the valve **19** passes all pressurized output from the pump **18** into the cylinder **16** below the piston **20**. Thus, the pressurized hydraulic fluid lifts the piston **20** with respect to the cylinder **16**. In a second mode, the valve **19** is set to release fluid out of the cylinder **16**, passing it back into the bottle **14**.

Thus, in mode one, the valve **19** is operated by an actuator **21** to move the valve **19** into mode one, pressurizing and holding the pressure in the cylinder **16** below the piston **20**. Mode two is a release of pressure and hydraulic fluid from the cylinder **16**, permitting descent of the piston **20** into the cylinder **16**, lowering any load that is being supported thereon.

A system of check valves may exist between the valve **19**, the cylinder **16** and the pump **18**. In operation, the pump **18** needs to be able to draw oil at comparatively low (ambient) pressure from within the bottle **14** and pressurize it within its own cylinder **29** by actuation of the shaft **28** or piston **28** of the pump **18**. However, that pressurized hydraulic oil needs to pass through a check valve such that the piston **20** cannot fall back into the cylinder **16**, when the pressure dwindles, decays, or reverses from the pump **18**. Thus, a one way check valve, as well understood in the art by that name, is placed in a line between the pump **18** and the cylinder **16**. This assures that pressurized oil can only travel one direction, that is, from the pump **18** into the cylinder **16** below the piston **20** or main piston **20**.

Upon release, the actuator **21** may be infinitely variable between the first and second positions in order to permit a comparatively slow descent of the piston **20** into the cylinder **16**. Typically, with the actuator **21** in a position somewhere between the first and second positions, oil does not flow from the pump **18** into the cylinder **16**, even if the handle **24** on the pump **18** is activated.

In that regard, the handle **24** is typically a lever **24** connected by a linkage **26** to an anchor **25** through several pivots **27***a*, **27***b*, **27***c*. Effectively, this assembly of components including the piston **28** or shaft **28** operates as a "four-bar linkage." This is a well defined mechanical mechanism understood in the mechanical engineering art. It is defined in any structural or design textbook for moving mechanical structures.

In operation, a system **10** in accordance with the invention may include an accessory **30** or a head **30**. Herein, the head **30** of a system **10** is not the same as a head in a conventional jack. A conventional jack may have a shaft or lifting mechanism of some type, on which will be located a flat or textured surface for lifting. It is not improper to speak of that top lifting surface or structures immediately related thereto or adjacent thereto as the head of a jack, with the screw or shaft therebelow representing a shat.

However, herein, the head **30** is defined as an assembly made up of a yoke **32** provided with certain attributes. For example, a yoke **32** will typically include a retainer **34** on at least one extreme thereof. For example, a yoke **32** includes a lift surface **36**. The lift surface **36** may be shaped to a particular desired contour to fit a specific shape or a specific range of objects to be lifted.

Between the lift surface **36** of a yoke **32** and a shaft **40** is a buttress **38** or buttressing material **38** that provides structural support and transfer of loading between the shaft **40** and the lift surface **36**. Vertical loading passes to the lift surface **36** from a supported load. Load is the weight through a component on a vehicle (e.g., truck axle, leaf spring, other suspension component, flat axle, round axle, "U" bolt, or the like) that will be lifted by the yoke **32** atop the bottle jack **11**.

The retainers **34** are not loaded vertically. The vertical load passes from the load to the yoke **32** by way of the lift surface **36**, thence into the buttress **38**, and ultimately into the piston **20** in the cylinder **16**. A threaded shaft **40** transfers load through threads into the piston **20** or main piston **20** of the bottle jack **11**. A smooth shaft carries no vertical load, but simply stabilizes the buttress **38**, which does carry load. The threaded shaft **40** and smooth shaft are examples of lifting shafts configured to be connected to a jack head **30** such as those illustrated in FIG. **2** according to various embodiments. Lifting shafts may be implemented in various lengths having a wide variety of cross-sections. Typically, lifting shafts are made of metal (e.g., steel, iron or other metal known to those of ordinary skill in the art) and have a round cross-section and a length that exceeds its circumference.

As a practical matter, the retainers **34** may be symmetric with one another or not. In certain illustrated embodiments, the retainers **34** may be higher on one side (e.g., retainer **34***a*), and lower on the opposite side (e.g., retainer **34***b*). This resolves the difficulty of adjusting height of a main piston **20** and necessarily the head **30** to minimize the gap between the head **30** and the load before engaging the pump **18** to lift the piston **20**.

Working underneath large vehicles, lateral registration presents a certain difficulty, often being not precisely determinable by vision. Thus, sliding a system **10** under an axle, leaf spring, "U" bolt, or the like, one may allow the lower retainer **34***b* to pass under the component that will eventually rest on the lift surface **36**, relying on the taller retainer **34***a* to register the yoke **32**, and head **30** generally, with respect to the lateral aspect of the lifted component. Nevertheless, the retainers **34** may be shaped, as may the lift surface **36** in a variety of embodiments as seen hereinafter.

In an apparatus **10** and method in accordance with the invention, blocking, cribbing, shimming, spacers, or the like may be placed under the base **12**. However, the lower retainer **34***b* may be shorter or non existent, with respect to the higher retainer **34***a*. In this embodiment, the upper retainer **34***a* may be used to register the head **30** laterally with respect to the load to be lifted.

The contact between the upper retainer **34** may occur with respect to a loaded component while the lower retainer **34***b* actually passes under that component. Thereby, additional distance may be provided by way of altitude of the lift surface **36***b* before it engages the pump **18** to lift the piston **20**.

The buttress **38** may be formed by any suitable process, including casting, forging, fabricating, cutting, and so forth. Thus, the strength of the buttress **38**, and the overall strength of the yoke **32** and the head **30** generally may be improved by using worked metals, such as rolled steel for forming the yoke **32**. Similar cast, forged, or worked materials such as rolled steel may be used for the shaft **40**.

Typically, it will be an improvement to cut a slot in the shaft **40** in order for the shaft **40** to contain the yoke **32**. Specifically, the buttress **38** will fit within a slot formed in the shaft **40**. Nevertheless, this could be reversed. However, it has been found structurally that the size of a shaft **40** necessary to support a load, and to fit within the piston **20** of the bottle jack **11** represents a diameter greater than the thickness of the yoke **32**. In fact, the shaft **40** may actually be hollow, representing a tubular structure sized to handle the loading in all dimensions that will be necessary for safety, suitable operation, long life, and so forth.

Cylindrical risers **42** may be used to adjust the height of the head **30** with respect to the piston **20**. Each riser has a hole through its central axis shaped to receive a shaft **40**. In conventional jacks, cribbing, spacers, blocking, platforms, or the like can adjust only the height of the base **12**. Some conventional jacks do have a threaded shaft that threads in and out of an inside cavity of a piston **20** to adjust the initial height of the jack **11** before engaging the hydraulic mechanisms that lift the piston **20**. This allows more efficient use of the very limited total distance of extension.

For example, any extension of a shaft **40** by threading it out of a piston **20** represents unloaded movement. This may be done without tools, with exertion of very little force. In contrast, once contact is made with the load, any lifting must be done by the hydraulic force from the pump **18** pressurizing hydraulic fluid under the main piston **20**.

In certain embodiments of an apparatus **10** or system **10** in accordance with the invention, risers **42** may operate to uncouple the shaft **40** from vertical engagement with the interior of the piston **20**. This provides certain benefits, and certain drawbacks. For example, having the head **30** immediately removable from within the piston **20** without tools is a convenience for changing out a head **30**, selecting an appropriate head for the shape or location of a component to be lifted, and so forth. On the other hand, a conventional bottle jack is a self-contained apparatus. Only the handle **24** or lever **24** used to operate the pump **18** is even separable from the jack. Moreover, a tire iron (lug wrench) may be used as a handle for an extension for a comparatively short handle **24**.

Several concepts for load paths will be discussed hereinbelow. They include threading the shaft **40**, threading the interior of the piston **20**, having either thereof threaded with the other smooth, or having both smooth. Thus, all combinations of threaded and smooth surfaces on the shaft **40** and piston **20** may be operable in a system **10** in accordance with the invention. Each provides different benefits, and poses different obstacles to implementation.

In various embodiments, risers **42** may provide spacing between the yoke **32** and the lifting end face of the piston **20**. In fact, a significant advantage in a system **10** and method in accordance with the invention is the load path. Hydraulic oil inside the cylinder **16**, is sealed below the piston **20** by a seal **20**. The seal **20** typically moves with the piston **20**. An 'O' ring near the top could work, but usually it is a seal **22** secured to the piston **20** and moving with the piston **20**.

From that pressurized reservoir, the cylinder **16**, the piston **20** is supported and lifted. It moves. Meanwhile, the load path does not pass between an interior surface of the piston **20** and an outer surface of the shaft **40**. Instead, load passes from the top surface of the piston **20**, an annulus to the yoke **32**. It may pass through an intervening shim **42** or riser **42** that adjusts the initial height of the head **30** with respect to the jack **11**.

Referring to FIGS. **2** through **10**, while continuing to refer generally to FIGS. **1** through **12**, one may see various embodiments for load transfer. In a conventional jack, having an adjustable shaft threaded with respect to a piston, the load path is carried by and includes threads. Thus, the load path is from the pressurized oil into the structure of the piston, then from threads on the piston into threads on the shaft, up the shaft, and into some lifting surface. Typically, the lifting surface is fixed with respect to a shaft, or is fixed with respect to the piston.

In contrast, the load path in a system **10** and method in accordance with the invention is from the oil into the structure of the piston **20**. The load path goes directly through an upper, annular surface of the piston **20** to either the buttress **38** directly, or a shim **42**. If a shim **42** is involved, then the shim **42** passes the load onto the buttress portion **38** of the yoke **32**. In either event, the shaft **40** itself does not actually carry any vertical load. For all practical purposes, it acts as a lateral stabilizer to prevent movement of the yoke **32** in the horizontal direction with respect to the jack **11**.

Referring to FIG. **2**, while continuing to refer generally to FIGS. **1** through **12**, one may begin viewing alternative embodiments of heads **30** for the jack **11** clockwise from the extreme left. In the first embodiment, the shaft **40** is threaded to receive a collar **44** or ring **44**. The collar **44** is threaded to spin up and down on the mutually engaged threads of the shaft **40** and collar **44**. The threads **46** on the shaft **40** engage with the threads **48** on the collar **44** or ring **44**. The collar **44** may be knurled, textured, fluted (having vertical ribs and intervening valleys for gripping), angled like a nut on a bolt, or the like.

The collar **44** without substantial frictional loads between itself and the upper annular surface **23** of the piston **20** turns comparatively freely. With proper tolerances and some modicum of lubrication, the collar **44** will rotate about the shaft **40**, thereby advancing up and down the length of the shaft **40**. In the illustrated embodiment, no engagement for vertical loading exists between the shaft **40** and the piston **20**.

The piston **20** may be threaded with a thread size and inside diameter that simply do not fit threads on the shaft **40**. In other embodiments, the internal surface of the piston **20** may be completely smooth. Thus, the shaft **40** is free to move vertically downward until the collar **44** is seated against the top surface **23** or annulus **23** of the piston **20**.

Upon contact, the collar **44** now transfers loads through its threads **48** to the threads **46** on the shaft **40**, thus supporting the shaft **40**. The shaft **40** then transfers loading into the buttress **38** of the yoke **32**. One will note that this view of the yoke **32** is cut away so that no retainers are shown. This is because an embodiment such as that shown may involve any set of retainers **34** discussed herein.

Moving to the next or second embodiment clockwise, the shaft **40** may be threaded along at least a portion of its length. In this embodiment, such a shaft **40** threads into a collar **44** or threads **48** on an inside surface of the piston **20**. Thus, one may think of the threads **48** piston **20**. The outside threads **46** are on a shaft **40**. Thus, the second and third embodiments counter clockwise from the left both have threaded shafts **40**, which may slip into smooth bores of pistons **20**, engaged threads **48** on inside walls of a piston **20**, or engage threads **48** of a collar **44**. Meanwhile, the second and third embodiments clockwise from the left illustrate a flat or comparatively flat lifting surface **36**, and a semi circular lifting surface **36**, respectively.

Any yoke **32** may be secured to any type of shaft **40**. In the fourth through sixth embodiments clockwise from the left, the shafts **40** are all shown as smooth. The difference between a smooth shaft and a threaded shaft is that a smooth shaft cannot engage threads for vertical loading. A threaded shaft **40** may engage threads for vertical loading, but need not do so.

Thus, the second and third embodiments may be rotated with respect to the piston **20** in order to provide initial height before engaging the pump **18** and lifting the piston **20**. On the other hand, they need not engage other threads. The fourth through fifth embodiments, may accept threads. If remaining without threads **46** all must all register vertically by fitting against the top surface **23** of the piston **20** or the risers **42**.

Meanwhile, the fourth embodiment shows a curved lifting surface **36**, and retainers **34** of even length or matched lengths. The retainers **34** in this embodiment may also have offset lengths as in the second embodiment.

The fifth embodiment from the left is actually a cylindrical or cup shaped yoke **32** on a shaft **40**. The shaft **40** may actually fit inside an inner diameter of a tubular yoke **32**. A cavity above the shaft **40** and within the yoke **32** is sized to receive a "U" bolt. Meanwhile, the "U" bolt nut fits against the upper surface of the yoke **32**, thus providing a convenient lifting location.

The sixth embodiment provides comparatively lower, typically even, retainers **34** restraining the lifted load and the yoke **32** with respect to one another. Thus, this head **30** need not rely on an exact fit, but simply provides some restraint against relative lateral motion occurring between the yoke **32** and the lifted load.

It has been found that a set of spacers **42** or risers **42** may be provided in the series of sizes. These may simply be based on individual units additive to one another. However, in one embodiment, one shim **42***a* may be one unit of height total, while another **42***b* is two units of height tall. A third **42***c* has four units of height. Thus, all combinations between one unit and seven units of height are available, in individual unit increments. A proper stack of one, two, or three at the spacers **42** goes on a shaft **40** before that shaft **40** is inserted into the piston **20**.

Referring to FIGS. **3** and 4A, while continuing to refer generally to FIGS. **1** through **12**, a cutaway view illustrates how threads **46** on a shaft **40** may engage threads **48** on a piston **20**. In this embodiment, load is transferred through the threads **46**, **48** between the piston **20** and the shaft **40**.

Thus, the buttress **38** below the support surface **36** or lifting surface **36** is supported by the shaft **40**. The shaft **40** actually transfers load to the piston **20** or exchanges loading with the piston **20** through the threads **46**, **48**. Of course, as described hereinabove, relying on threads **46**, **48** depend on their matching in pitch, size, diameter, and so forth. A smooth shaft **40** may be placed in a threaded head cavity of a piston **20**. A threaded shaft **40** may be placed in a smooth head cavity of a piston **20**. The head cavity is the hollow portion of the piston **20** that the shaft **40** of the jack head fits down within.

Referring to FIG. **4**A, while continuing to refer generally to FIGS. **1** through **12**, an embodiment having a smooth shaft **40** and a smooth interior surface of the piston **20** relies on the shaft **40** only for lateral support against tilting or shifting. Meanwhile, vertical loading occurs through the upper surface **23** of the piston **20** against either the buttress **38** of the yoke **32**, or through the spacer **42**. In some embodiments the shaft **40** is retained inside the piston **20** solely by gravity. In other embodiments a flexible collar such as O-ring **43** or other collar made of rubber or other flexible material may be fitted inside the piston **20** as shown in FIG. **4**B to provide some friction for holding the shaft **40** within the piston **20** in addition to being held in by gravity. In other embodiments the shaft **40** may be held in place by a mechanical keeper such as a pin, a spring loaded **51** ball bearing **45** positioned in a slanted groove inside the piston **20**, or other like type of mechanical structure for holding a shaft as are known by those of ordinary skill in the art. For those embodiments with a spring loaded **51** ball bearing **45** mechanical keeper the shaft **40** may have flat sides **53** or grooves that can be aligned with the spring loaded **51** ball bearing **45** mechanical keeper in order to remove the shaft **40**.

Referring to FIG. **5**A, while continuing to refer generally to FIGS. **1** through **12**, an example of a threaded interior head cavity of a piston **20** is simply bypassed, not supporting the shaft **40**, because the shaft **40** is not threaded. In this embodiment, the top surface **23** of the piston **20** supports the yoke **32**, or supports the yoke **32** on an intervening riser **42** or spacer **42**.

FIG. **5**B depicts a head **30** with a threaded shaft **40** similar to the head **30** shown in FIG. **3** and described above. A threaded bushing **31** is provided according to various embodiments with female threads that match the male threads of shaft **40**. The piston **20***a* of FIG. **5**B is bored out or otherwise formed to have a multi-diameter head cavity with smooth interior walls. By "smooth" it is meant that the interior walls of the piston **20***a* are non-threaded, that is, they do not have threads. The lower portion **20***d* of the multi-diameter head cavity in piston **20***a* in various embodiments has a smaller diameter than the upper portion **20***c*, leaving a shelf **20***b* at some point down within the piston's multi-diameter head cavity. The lower, smaller diameter portion **20***d* of the multi-diameter head cavity in piston **20***a* is of a sufficient diameter to accept the threaded shaft **40** of head **30**. Since the walls of the lower head cavity portion **20***d* are not threaded they offer no vertical support to the threaded shaft **40** of the head. The upper, wider diameter portion **20***c* of the piston head cavity is of a sufficient diameter to accept the threaded bushing **31**. The load path passes from shaft **40** of head **30** through the threaded bushing **31** and to piston **20***a* through shelf **20***b*.

The threaded bushing **31** may be screwed up and down the shaft **40** to adjust the height of the head **30** of the lifting device. In some situations it is useful to be able to adjust the head up and down without removing the bead from the piston head cavity to adjust the threaded bushing **31**. To avoid having the threaded bushing **31** rotate along with the shaft (and thus not move up or down) a groove may be machined or otherwise formed around the circumference of the threaded bushing **31**, with flexible collar such as an O-ring **33** or other flexible material fitted into the groove. The O-ring **33** protrudes outward from the grove by an amount that is sufficient to rub against the sides of the upper piston head cavity **20***c*. The frictional contact between the O-ring **33** and the upper head cavity wall **20***c* aids in preventing the threaded bushing **31** from rotating as the head **30** is turned to adjust the head up or down. This aids in keeping the threaded bushing stationary with respect to the piston **20***a* as the head **30** is being turned to adjust it up or down by threading the threaded collar **31** up or down its shaft. In other embodiments, the surface of shelf **20***b* and/or the bottom surface of threaded bushing **31** may be provided with a rough texture that aids in preventing threaded bushing **31** from rotating as the head **30** is turned to adjust the head up or down. Depending upon the requirements of the implementation the shelf **20***b* may be positioned at various heights along the piston head cavity. For example, the shelf **20***b* may be as high as 99% (towards the top) of the piston head cavity or as low as 10% (towards the bottom) of the piston head cavity.

Referring to FIG. **6**, in certain aspects of an apparatus and method in accordance with the invention, a shaft **40** may be provided with a head **30** formed in the shape of a yoke **32**. The yoke **32** of head **30** is characterized by a yoke width W and a yoke depth D. In various embodiments the yoke width W is at least four times as long as the yoke depth D. The yoke **32** may be characterized by a lift surface **36** flanked on each extreme thereof (e.g., right end, left end, etc.) by retainers **34**. In the illustrated embodiment, a first retainer **34***a* is shorter or lower, extending away from the shaft **40** less distance than does the upper or longer retainer **34***b*. The retainer **34***b* provides a registration aid **34***b* to position and orient a jack system **10** beneath a load, such as a trailer, truck, or the like.

One benefit to a system **10** in accordance with the invention is the ability to lift extremely heavy loads, over 10,000 pounds, and often involving axle of a heavy, over-the-road truck or its trailer at a remote location on a dark highway at an inconvenient hour, such as in the middle of the night. Such trucks may carry over 20,000 pounds of load. Of course the entire load is not a particular axle or a particular wheel. Nevertheless, once an axle is lifted to remove the tire from the ground (supporting surface), the jack is then supporting all load bearing on the lift point, typically a portion of the suspension (e.g., springs, shackles, U-bolts, etc.). by having a shaft **40** as a single element **40** rigidly welded or otherwise permanently and fixedly secured to the head **30**, the shaft **40** provides a significant "bearing length." The principle of a bearing length is that every manufactured component or device has to have tolerances. If tolerances are too close, then fitting two parts together is a laborious careful process. If tolerances are too loose or relaxed, then slack, backlash, slop, tilting, movement, dis-orientation, and the like may result.

For example, a stack of checkers may be extended by addition of one checker at a time. However, without some type of engagement, the stack of checkers is very unstable. For this reason, checkers typically have an edge pattern of depressions and extensions that mate with one another to support against lateral movement of one checker with respect to another, once engaged.

Similarly, providing extensions constituting a shaft **40** in incremental pieces, each engaged by some engagement mechanism, such as pins, apertures, sockets, and stubs fitted to one another, or the like, provides a dilemma. Quick assembly and disassembly requires relaxed (large) tolerances. Stability requires close (small) tolerances.

By having a shaft **40** that is a single unit, the entire portion of the shaft **40** that sits within a cylinder **16** containing a piston **20** of a bottle jack **1** constitutes the bearing length. Accordingly, a comparatively larger bearing length may accommodate a relaxed tolerance making it easy to insert and remove a shaft **40** from inside the piston **20**. The shaft **40** sits at least partially inside the piston **20**. The piston **20** is driven by the pump **18** upward to extend out of the cylinder **16** containing the piston **20**.

By placing a band **41** or mark **41** on the shaft **40** one may establish a bearing length **39** that will remain inside the piston **20** during operation and thereby provide stability against excessive tilting or other displacement or deflection of the shaft **40** with respect to the piston **20** and the bottle jack **11**, generally.

In one embodiment, height adjustments to adjust the height of the head **30** above the upper surface **23** of the piston **20** may be done by risers **42**, shims **42**, or adjusters **42**. These adjusters **42** may be formed as collars **42** or rings **42** acting to space the head **30** above the upper surface **23** of the piston **20**. The spacers **42** may be added in suitable increments.

In contrast to the shaft **40** with its threads **46** in FIG. **5**A, the spacers **42** (e.g., **42***a*, **42***b*, **42***c*) are not fixedly engaged to the shaft **40**. For example, the collar **44** is threaded to travel along the threads **46**, and thus fix the position of the collar **44** with respect to the shaft **40**, thereby establishing a bearing length **39** below the collar **44**, and an extension length above the collar **44** (closest to the head **30**).

In the embodiment of FIG. **6**, in contrast, the spacers **42** are free to move with respect to the shaft **40**, but are restrained by the head **30** thereabove, and the upper surface **23** of the piston **20** therebelow. For example, a user may invert the shaft **40** in space, drop one or more spacers **42** onto the bottom end of the shaft **40**, and then place the bottom end of the upright shaft **40** into the piston **20**. The shaft **40** will sink into the piston **20** until the top surface **23** contacts and stops the spacers **42**, with the spacer **42** being driven downward by the weight or force of the head **30** and shaft **40**. Thus, the head **30** and shaft **40** are stably supported by the piston **20** in the bottle jack **11**.

In the illustrated embodiment, the spacers **42***a*, **42***b*, **42***c* may be of different sizes (lengths). For example, if the spacer **42***a* is one unit of some length dimension in height, then the spacer **42***b* may be two units high. Similarly, the spacer **42***c* may be four units (increments) of distance in total height. Accordingly, combinations of zero space between the head **30** and the top surface **23**, one unit increment, two increments, three increments, four increments and so forth up to seven unit increments are all available by various combinations of the spacers **42**. Thus, all lengths from zero to seven in discrete increments of one single unit of height (length) may be available.

In some respects, a system **10** in accordance with the invention is considerably more complex than a conventional, inseparable system and requires more sophistication for use. However, a system **10** in accordance with the invention is designed to support large loads, typically vehicles having a gross vehicle weight (GVW) greater than about 9,000 pounds. This includes, typically, common carriers used for over-the-road transport. Semi tractor trailer rigs are typically a dominant population in such vehicles.

On a dark night, underneath a large trailer on a remote roadway, a mechanic or technician can set a bottle jack **11** underneath a lifting point selected on a vehicle. Estimating the approximate height of the lifting point above the bottle jack **1**, and specifically above the upper surface **23** of the piston **20**, the user may select a particular head **30** on its shaft **40** of suitable length (height) and some combination of spacers **42**.

Dropping the spacers **42** onto the shaft **40** in the upside down position, the technician is warned by the marker **41** against leaving less than a minimum bearing length **39**. Holding the bottom end of the shaft **40** will maintain the comparatively lightweight (compared to the shaft **40** and head **30**) spacers **42** on the shaft **40** while the bottom end of the shaft **40** is inserted into the piston **20**.

A user may now slide the bottle jack **11** more-or-less horizontally along the supporting surface until the high retainer **34***b* registers against the components about the lift point on the vehicle. For example, the retainer **34***b* may strike the side of an axle, the side of a spring, the side of a shackle, or the like. Thus, the lift surface **36** is in position to be elevated by operation of the pump **18** lifting the piston **20** to make contact between the lifting point (surface, etc.) and the contact surface **36** or lifting surface **36**.

The high retainer **34***b* provides registration and prevents the head **30** from slipping out from under the lift point or lift region once lifting has begun. It is well known that jacks may tilt as a swing arm, anchoring a lift point to a frame of a vehicle, will swing in an arc as the suspension system is compressed with the added weight or force locally imposed by the jack. This places more of the load of the vehicle on that particular area of the suspension system.

Thus, the retainer **34***b* permits a user to rely on contact and physical engagement to register (e.g., align, fit, contact, position, fix, etc.) the head **30** horizontally (e.g., along the ground or road) with respect to the lift point or lift region, knowing affirmatively where the head **30** is located. Otherwise, a user may have to rely on eyesight, which may not even be possible. For example, in darkness, with lift points behind other equipment or components, and so forth, a user can set the head **30** by feel, knowing that the retainer **34***b* has struck and registered with a side of a component near, or part of, the lift point (usually a contact region above the head **30**) that will contact the necessary lift surface **36** of the head **30**.

Referring to FIG. **7**A through FIG. **7**G, while continuing to refer generally to FIGS. **1** through **12**, in certain embodiments, a design is shown in particular detail for a head **30**, in accordance with the invention, having a yoke **32** with retainers **34** that are not symmetric. This embodiment uses a flat lift surface **36**, and illustrates a smooth shaft **40**.

Referring to FIGS. **8**A through **8**E, an alternative embodiment of a head **30** in accordance with the invention may rely on a semicircular lift surface **36**, whether or not that surface actually covers an entire semicircle. However, many large vehicles (e.g., trailers) have tubular axles. Accordingly, capture of those axles and lifting thereof in a semi circular yoke **32** may be advantageous. As with FIGS. **7**A through **7**G, the shaft **40** illustrated is shown as smooth, but need not be so in all embodiments.

Nevertheless, as described hereinabove, all embodiments may rely on a threaded shaft **40**, a smooth shaft **40**, or the like. This simply changes the operational method and the load path. Of course, such changes still require the alternative load path, which is not supported by conventional systems. By use of a head **30** in accordance with the invention, certain conventional systems may be converted to operate with a head **30** in a retrofit manner.

For example, in certain embodiments, a conventional jack may be dismantled, by forcing the shaft threads to distort sufficiently or deflect sufficiently. This deflection may be plastic (yielding), elastic (temporary), or a combination. A shaft **40** may be threaded out from an internal thread on the hydraulic piston **20**. In such a manner, the shaft **40** may be damaged, but is no longer necessary. It may be replaced with a head **30** on a shaft **40** in accordance with the invention having a smooth shaft **40**, a threaded shaft **40**, or the like, fitted inside the piston **20**.

One advantage to having a smooth shaft **40**, making the load path not pass through shared threading between a shaft **40** and a piston **20**, is that the yoke **32** may be rotated to slip readily under a loading location (lift point), such as an axle, leaf spring, "U" bolt, spring shackle, or the like. Thus, it is a convenience to be able to rotate the shaft **40** readily within the piston **20** without changing elevation, or without requiring a change in elevation.

For example, a coupling may be built to permit rotation of a head **30**, yoke **32**, or both with respect to a shaft **40**. However, replacing fixed junction or weld between a yoke **32** and a shaft **40** with a rotary joint causes difficulties with stress (force per area), strain (stretch or shrinkage), yielding (failure, plasticity), misalignment, galling (surface abrasion), stability, and so forth. Moreover, the load path from the shaft **40** through the yoke **32** into the lift point or lift region of the load may become weakened by that rotating joint. Nevertheless, such may be provided and may be thought of as a rotary joint replacing the weld between a shaft **40** and its yoke **32**.

Certain inconveniences are added compared to conventional bottle jacks. For example, the unitary self containment is lost. However, in certain situations, most particularly commercial repair services for large over-the-road trucks, the safety of bottle jacks is constantly in question. Uneven terrain on which to set the jack, difficulty in line-of-sight positioning, mismatched surfaces between the top surface of a jack and the bottom surface of a lifting location on the vehicle, horizontal shifting of a lift point as it rises, and so forth all conspire to render field use of a conventional bottle jack dangerous. A smooth, flat floor of a shop or garage, with the neat, specialized floor jacks and trolley jacks on precise steel wheels are not a practical option "on the road."

In contrast, here, a yoke **32** in accordance with the invention may stabilize the bottle jack **11** with respect to the lifted load, capturing on any of the illustrated lift surfaces **36** the appropriate surface of a lift location. Thus, for example, a circular axle will engage with substantial lateral stability a system as in FIG. **8** (where FIG. **8** refers to the FIGS. **8**A through **8**E). likewise, other custom shapes may be used.

Referring to FIGS. **9**A through **9**B, various views show a head **30** having a yoke **32** constituted by a tubular member or cup welded or otherwise secured to a shaft **40**. Each is sized to receive the extension of a "U" bolt protruding through the nut capturing that "U" bolt about an axle and spring assembly. Here, the upper surface **50** of the yoke **32** is effectively an annulus. Meanwhile, the bottom thereof may fit on top of the annular surface **23** at the top of a piston **20**. Thus, the load path (the mechanical regions through which force and stress are transferred between the ground and the vehicle frame that is supported by the suspension) is well supported, and the shaft **40** operates simply to orient the yoke **32** with respect to the piston **20**.

Referring to FIG. **10**A, while continuing to refer generally to FIGS. **1** through **12**, the profiles of the various embodiments are illustrated. Beginning clockwise from the lower left, a typical shaft **40** may support a yoke **32** of a size and shape selected to match a particular component that will be used as the lift location by a commercial operator.

For example, a tire shop or repair truck may carry a kit comprising one or more of the illustrated embodiments of heads **30** and several jacks **11**I. Each of the heads **30** includes a yoke **32** and shaft **40**. Each of these heads **30** may be adapted to the use to which it will be put. The embodiments of heads **30***a*, **30***c*, and **30***e* have a high retainer **34***a* and a low retainer **34***b* described hereinabove. Meanwhile, the heads **30***b*, **30***d*, **30***f*. **30***g*, and **30***h* represent some longer or comparatively shorter retainers **34**. The head **30***d* has a yoke **32** with a rather elongate curvature on the lifting surface **36**. The surface **36** may be semicircular, but is not matched to actually accept a full semicircle between the retainers **34**.

Many axles are substantially rectangular in cross section, but may have a certain curvature due to their engineered design or manner of forming, such as forging, casting, and the like. Meanwhile, curved axles that have a smaller diameter than the effective diameter of the lifting surface **36** may also rest on the lifting surface **36**.

Meanwhile, the comparatively longer retainers **34** of the heads **30***b* and **30***f* are even and symmetrical with respect to one another. Similarly, shorter symmetric retainers **34** in the head **30***d* forfeit some of the ease of horizontal registration before engagement with a lift point. The semicircular embodiment **30***f* with symmetric retainers **34** is formed continuously and contiguously with a buttress **38** to form the semi circular lifting surface **36**.

Any of these embodiments may lift a circular or a rectangular cross section and maintain it between the appropriate retainers **34**. However, selecting a shape for the lift surface **36** that matches most closely the lift point (region) on the load provides significant safety through resistance against slipping, sliding, or horizontal movement that may result in tipping a jack **11** on its side or otherwise shifting it or kicking it out of place.

One will note that the sixth embodiment clockwise provides a semi circular form of the lifting surface **36**, having non symmetric or disparate heights between the retainers **34**. Again, the tubular or cup-shaped yoke **32** is the seventh clockwise embodiment. The shafts **40** are cut away here indicating that any of these shafts **40** may be any of the shafts **40** identified hereinabove.

Thus, load paths that engage threads to threads or smooth to smooth may be used. Load paths that ignore threads present and use threads adjacent to smooth surfaces to provide lateral alignment and stability without vertical load lifting may also be embodied. The threaded and smooth surfaces may exist on the shaft **40**, on the interior surface of the piston **20**, both, or neither.

In certain embodiments of an apparatus **10** or system **10** in accordance with the invention, one may adjust the top height a bottle jack **11** in accordance with the invention by using blocking, cribbing, spacers, shimming, or the like below the base **12**. Meanwhile, trimming up the position of the lift surface **36** of the head **30** below the lifting location may be done by any of several methods described hereinabove. Meanwhile, the shaft **40** may typically be longer in a system **10** in accordance with the invention than a conventional shaft.

Conventional shafts have many limitations on them, not the least of which is column buckling, possible bending, and the like. Moreover, shear strength, failure, or damage to threads will limit the extension that such a shaft may have outside of a piston. In contrast, in a system **10** and method in accordance with the invention, a longer shaft **40** may consume any part or all of the length inside a main piston **20**. Thus, a longer bearing length (in engineering parlance, this expression refers to the maximum dimension between points at which an extended member is "supported" when loaded, and thereby provides additional stability or leverage with a longer bearing length than is provided with a shorter bearing length) provides additional stability and strength.

Safety may be somewhat enhanced by a smooth shaft that does not operate on the mere engagement of a few threads that may fail, causing injury, damage, death, or any combination thereof. Thus, one may think of the spacers **42** as providing pre-adjustment or trimming of the initial or starting position that a head **30** occupies. Particularly a mechanic usually want any lift surface **36** to be in a position as close as possible to a lift point under a lifted load prior to operating the pump **18** to extend the piston **20** of the bottle jack **11**. One desires to take up any gap therebetween to leave a maximum extension effect for the piston **20**.

It may be required in certain embodiments to lose "infinitely variable" pre-adjustment available in an integrated system. It is contemplated that in its most robust or adaptable form, a system **10** in accordance with the invention will lose the convenient, integrated construction of conventional bottle jacks. This provides to a skilled commercial user a universal system **10** that can safely handle various shapes, sizes, heights, and locations as described hereinabove, of lifting points on a vehicle or other load, with the same bottle jack **11** without precarious tilting, for example. Thus, a certain amount of compactness of fully integrated construction is lost, in favor of more safety and adaptability. The goals of improved performance, substantially increased safety, and more operator discretion result for the head **30** under the load. Loads are easily registered horizontally, laterally engaged against slipping out from engagement, and affirmatively captured during all lifting.

A system **10** in accordance with the invention may still use for blocking or shimming below and trimming above prior to loading. This provides a longer effective throw or lift distance for the head **30** on or in the piston **20** and for the jack **11**, generally. A longer shaft **40** in accordance with the invention provides addition bearing length to resist tilt, yielding, popping out of the piston **20**, or to accommodate coarse tolerances on sizes.

For example, in many embodiments, of vehicles, the suspension systems are such that upon lifting away from the road surface or underlying earth surface, the lifting surface **36** may move, or the lift location may move in an arc. Accordingly, the jack **11** may be forced to tip. In such an embodiment, the retainers **34** may assist in maintaining alignment, and permit the jack **11** to actually tilt somewhat, while not risking the load slipping out of engagement therewith.

In other embodiments, until loads are maximized, a jack **11** may slide along the set of cribbing or other spacing therebelow in order to track the load being lifted and its particular position. Meanwhile, the bearing length of the shaft **40** within the piston **20** permits much higher trim distances without sacrificing the lateral stability of the shaft **40** in the piston **20** or with respect to the remainder of the jack **11**.

This provides yet another benefit in accordance with the invention. Various heads **30** may have different lengths and shafts **40**. For example, there are no fundamental reasons why a shaft **40** may not be many times longer (with or without spacers **42**) than a conventional shaft on a jack, and thereby provide an extension away from the piston **20** by the head **30** all within the head **30** itself. This provides a much simpler method of use, more stability, and less danger than conventional jacks of many varieties.

Moreover, the attachments **30** or heads **30** in accordance with the invention can be sized to fit any particular inner diameter and annulus **23** of any particular piston **20**. Thus, the piston **20** may have its size dictated strictly by axial loading, and not by thread loading. Thus, so long as the piston **20** and shaft **40** are configured to resist failure under axial load, under column buckling modes, these may be sized to support substantially larger loads than might otherwise be carried thereby.

Thus, simpler methods of use, self centering, stability, capture of the lifted load, better functioning, even if the base **12** does tilt somewhat with respect to the horizontal dimension, and so forth all provide a useful kit as either an add-on accessory **30** the head **30** alone or as a system **11** built as a production unit. Meanwhile, jacks **11** may be built with individual yokes **32** as shown, or to quickly receive, use, and remove any particular head **30** with its particular shape of yoke **32**.

FIG. **10**B depicts six implementations of lifting heads according to various embodiments. Lifting head **65** has a symmetrical yoke with retainers that are approximately 1 inch tall of equal height. Lifting head **67** also has a symmetrical yoke with a lifting surface that is slightly concaved. Lifting heads **65**-**69** each have smooth, non-threaded shafts. Lifting heads **67** and **69** each have a multi-diameter shaft. Lifting heads **71**-**75** each have threaded shafts. Lifting heads **71**-**75** are each depicted with a threaded bushings **71***a*-**75***a* removably attached to each respective one. The threaded bushings **71***a*-**75***a*, when used in conjunction with a lifting member having a multi-diameter cavity, allow the height of the jack head to be adjusted up or down, as described in further detail above in conjunction with FIG. **5**B.

Referring to FIG. **11**, a method **60** is provided for creating a system **10** in accordance with the invention. Providing **62** a jack, particularly a bottle jack **11**, may be done by manufacturing a bottle jack **11** to order as discussed hereinabove or by converting a bottle jack **11** originating with some other supplier. The details of bottle jacks and how they work are well understood, and sufficiently details are discussed hereinabove.

In one method **60** one may provide **62** a bottle jack **11** by purchasing a conventional bottle jack, of conventional design, and maximizing **64** the extension of the shaft **40** within the piston **20**. This will involve rotating the shaft **40** until the shaft **40** can rotate no longer within the piston **20**. At that point, one must fix the piston **20**, against rotation, if it does not have such a mechanism already built into the bottle jack **11**.

Thereafter, one must forcibly rotate the shaft **40** such that it yields, deflects, or otherwise breaches **66** the locking mechanism that prevents over extension of the shaft **40** in the piston **20**. Typically, one or more of the lowest threads **48** on the shaft **40** may have been yielded by a punch, press, or the like in order to misalign them, making them not match and not pass through the threads **48** of the piston **20**. By forcing the shaft **40** to overextend, the locking element has been forced (yielded, failed, deflected, or all thereof) and thereby breached **66**. Thereafter, the shaft **40** may be further rotated in order to remove **68** the shaft **40** from the piston **20**.

The steps **64**, **66**, **68** may be considered optional. That is, for example, steps **64** through **68** are a mechanism or method central to retrofitting a conventional jack. Thus, since a conventional bottle jack **11** is not manufactured to receive a smooth shaft **40** as illustrated in FIGS. **6** through **10**, or a threaded and collared shaft **40** as illustrated in FIG. **5**A, then it may be retrofitted with such.

Next, one may replace **70** or place **70** a shaft **40**. This replacement step **70** may include selecting **72** a head, fixing **74** (e.g., welding) a head **30**, actually the yoke **32**, to a shaft **40**, and setting **76** a bearing length **39**. Setting **76** a bearing length **39** may involve setting the entire length of the shaft **40** by selecting such a shaft, selecting its diameter, and so forth. Thus, replacing **70** a shaft **40** will necessarily include selecting a shaft **40**, and selecting a head **30** shape or yoke **32** to be welded or otherwise fixed thereto.

Providing **78** an elevator may involve the addition of either a collar **44** on the threads **46** of a threaded shaft **40**, or selecting a set of spacers **42** to be fitted on a smooth shaft **40**. Of course, the spacers **42** may also be used on a threaded shaft **46**, but mechanically a smooth shaft **40** will necessarily be stronger, stiffer, and provide less chance of interference between threads **46** on the shaft **40** that are with the threads **48** that may be left or may remain inside the piston **20** in a retrofit embodiment.

Providing **78** an elevator may involve the selection and fabrication **82** of a continuous elevator **44** (such as the collar **44**), or selection and creation **84** of a discrete elevator **42** (shim **42**, adjusters **42**, etc.), such as the spacers **42***a*, **42***b*. **42***c*, and so forth. Providing **82** a continuous collar type elevator **44** provides finer adjustments. Providing **84** a discrete elevator **42** (shim/adjuster **42**) allows for faster but discrete adjustment of height. Limited, discrete, extension heights may be selected to be available for elevating the head **30** above the piston **20**.

Forming **80** kits may involve assembling one or more jacks, one or more heads, fixed in advance to their shafts, as well as elevating members **42**, **44**. For example, a kit may include several heads **30** of different types including several heads of the same type on various shafts **40**, corresponding thereto, having various lengths. Similarly, a suitable number of spacers **42** may be provided. The illustrated embodiment of FIG. **6** shows a system of three spacers **42**, but any number of spacers **42** may be used, with different incrementing schemes.

For example, a "base-two" length system may simply add spacers **42**, each twice the size of the next lower. Other embodiments may choose particularly useful lengths for the spacers **42** according to typical heights of axles, spring shackles, springs, U-bolts, U-bolt plates, and so forth. U-bolt plates are located near the threaded ends of U-bolts, and are the plates against which the nut is tightened on a U-bolt thread.

Also, forming **80** kits may involve selection of any number of yoke **32** defining the heads **30**. For example, a user may desire to have multiple cup-shaped yokes **32** for heads **30** (see FIGS. **9**A through **9**D), of different diameters, and having different shafts **40** of different lengths. Similarly, a user may have preferences as to shapes of yokes **32** for heads **30**, including flat, semicircular, or the like lift surfaces **36**. Similarly, a choice of height of the long retainer **34***a*, or the presence of a long retainer **34***a* at all, may be a choice. Ultimately, a kit containing a system **10** will be formed **80** for sale or use.

A method **90** for setting up a service truck may include selecting **92** one or more jacks **11**. Selections may be based, for example, on tonnage **94** or lifting capacity **94**, the controls **96** or control system **96** including hydraulic oil supply, pumping system, power supply, lifting and descending controls **96**, and the like. Similarly, one may select a start height **98** for a piston **20**, as well as a maximum height **100** for the piston **20**, head **30**, and shaft **40** supporting a yoke **32**, at the maximum height of the lifting surface **36**. Elevator types **102** may be selected **102** along with head types **104** as described hereinabove. Various shapes, options, sizes, thicknesses, and so forth, as well as the fundamental geometries may be selected **102**, **104** for the elevator **102** and head types **104**. Herein, the blocks of the schematic illustration represent both the hardware, and the selection or creation thereof.

Selecting **106** heads **30** may involve selecting and creating **108** the shape of the yoke **32** that forms the head **30**, creating **110** the register offset relating the relative distance between the lift surface **36** and the registration retainer **34***b*. Likewise, the shaft geometry **112** may be round, smooth, threaded, hexagonal, rectangular, or of some other shape. Accordingly, selection **112** of a shaft **40** geometry may be done in conjunction with elevators **42** selected **114** for that particular shaft geometry **112**.

Other factors **116** may be considered or designed in selecting **106** or otherwise providing **106** a head. Thus, the process **90** may then proceed to assembling **120** a system **10** for a service truck according to the available options. A user may assemble **120** a system **10** according to considerations of size **122**, weight **124**, various operational options **126**, and history **128**.

For example, as with most operations, the operational options **126** may be informed by history **128** of a user. Accordingly, certain sizes, weights, head (yoke **32**) types **104**, elevator **42** types **102**, and the like as well as maximum heights **100** may be more useful than others. Accordingly, a system **10** may be assembled **120** to make it more useful while being lighter or smaller, or not. Thus, transport **130** and operating personnel **132**, including their personal preferences may influence the assembly **120** of a system **10** based on the available options. Thereafter, having a system **10** available, the system **10** may be deployed **140** on demand.

Referring to FIG. **12**, while continuing to refer generally to FIGS. **1** through **12**, the actual method **140** of use may involve selecting **142** a jack **11**, selecting **144** a head **30** shape (yoke **32** shape), which will be fixed to a particular shaft **40** selected **146**. Thus, selecting **144** a head **30** and selecting **146** a shaft **40** involve selecting a unit that includes the desired yoke **32** and shaft **40**. Selecting **148** adjusters **42**, **44** or elevators **42**, **44** may be included with or likewise depend on the pre-configured shape and operational characteristics of the shaft **40** selected **146** fixed to a yoke **32**.

With a jack **11** and the shaft **40** and adjusters **42**, **44** selected **146**, **148**, one may assemble **150** the adjusters **42**, **44** on the shaft **40**. Thereafter, the shaft **40** may be assembled **152** into the jack **11**, and particularly into the piston **20**. One may set up **154** the jack **11** on a roadway (supporting surface) near a lift point. This may be done by physically moving the jack **11** under the lift point, with the assembled **150**, **152** system **10** as a unit **10**.

The shaft **40** may be extended by elevating the piston **20** a suitable distance at which the lower retainer **34***b* will clear the lift point, and the longer or higher retainer **34***a* will not. The jack **11** may then be moved by sliding horizontally along the supporting surface until the higher restraint **34***b* contacts a structure, thereby aligning the lifting surface **36** with the lift point or lift surface **36**. Such a registration **156** of the head **30** may be done by pushing or sliding the system **10** away from a user toward the lift point, or by drawing the system **10** toward the user from an opposite side of the lift point.

A user may select the method by which visibility will be improved, or touch and sound are relied upon as an aid, building confidence that a well aligned registration **156** may be assured. After registering **156** in a lateral or horizontal direction the head **30**, one my engage **158** or capture **158** the lift point within the yoke **32** bounded by the retainers **34***a*, **34***b*. At this time, the piston **20** may be brought up so that the lifting surface **36** contacts the lift point, or short of that, so that the retainers **34***a*, **34***b* restrain lateral motion, or horizontal motion nominally, but yet permit further sliding of the base **12** of the bottle jack **11**.

In this way, one may adjust **160** the position of the bottle jack **11** for tilt. This may involve actually tilting the jack **11** in some circumstances. It may simply involve sliding horizontal (nominally) on the supporting surface (road, road bed, etc.), or may involve actually tilting the jack **11**. If the bottle jack **11** is actually tilted, then stabilizing **162** the base **12** may involve shimming the base such as by placing thin wedges to accommodate the flat base **12** on the bottle jack **11** to any misalignment with the underlying supporting surface or road base. Operating **164** the pump **18** will now elevate the head **30**, making contact between the lifting surface **36** and the lift point or lift area of the vehicle being lifted. Meanwhile, the retainers **34***a*, **34***b* maintain **166** registration and engagement of the lift surface **36** with the yoke **32**.

A system in accordance with the invention provides a stable platform and a stable shaft **40**, with no balancing act required to keep a lifting point fixed in relation to the yoke **32** of the head **30**. Instead, a retainer **34***a* registers (aligns) the lifting surface **36** under a desired lifting point. Spacers **42** or elevators **42** are stable in use on a shaft **40**, yet easily and quickly removed or added, rather than requiring slow turning of threads.

Safety against disengagement of the shaft **40** from inside the piston **20** is provided by markings **41** establishing a bearing length **39** therebelow. Tolerances may be determined along with the bearing length to assure stability and rigid body movement of the piston **20** and head **30** together.

The yoke **32** will register the jack **11**, which can be moved horizontally on its base **12** by simply releasing lift pressure enough to provided working space to slide the jack **11** while the retainers **34** remain engaged, even when the lift surface **36** is not loaded or even in contact with the lift point. After any such adjustment, lifting can begin again.

Tilting of the jack **11** after a load has been lifted partway may be ameliorated by shimming with blocks or wedges, for stabilizing "purchase" of the base **12** on the supporting surface. The top of he head is unaffected, and the piston **20** need not be released to descend. Instead, the yoke **32** remains engaged throughout, capturing the component on which the lifting point (usually a lifting area) is found.

Creating a system **10** may be done by retrofitting a conventional jack after extracting the factory installed shaft contained therein. Alternatively a separable-component-bottle-jack may be fabricated in which the head **30**, with its solid shaft **40** and yoke **32** as an integral unit **40**, is separated or assembled with the piston **20** of the jack **11** at will, rapidly, and without tools.

Meanwhile, the entire head **30** can be turned at will if not loaded (load being a force or pressure applied, usually by an object having weight). Thus rapid positioning of a yoke is available in four degrees of freedom (e.g., height or elevation, rotation, horizontal left/right or forward/backward under a vehicle) to fit under a bracket, leaf spring, spring shackle, axle. U-bolt or other location on a suspension system. Registration (horizontal alignment by contacting a component) is easily done, even without clear sight.

No double jacking (using one jack, setting a fixed block or holder, dropping the jack head, putting more blocks under the jack after moving the jack location, lifting again, repeating, etc.) can be done away with. Shifting by jacks during a lift, and calculating risks of loads falling caused thereby, can largely be eliminated. No unique training or retraining on the use of some new jack is required. The shaft **40** simply slides in and out of the piston **20** instead of threading. Elevation offset or pre-set height can still rely on blocks below, but can elevation (spacing) may be done continuously or discretely.

In some embodiments, a component such as an axle can slide along a flat lift surface **36**, yet remain captured by the retainers **34**, with little or no risk of danger from excessing tipping, or sliding off the head **30**, because of the shape of the yoke **32**. Thus motion that might otherwise urge tipping is accommodated with no shift in the jack **11**.

The shaft **40** may be tapered at the bottom end to pilot quickly into the piston **20**. Changing out heads **30** is quick and easy, with only the weight of the head **30** and spacers **42** being lifted in and out as the jack **11** stays on the ground.

The O-ring used in various embodiments, for example, O-rings **33** and **43**, may be made from various materials and have a number of different cross-sectional profiles (as viewed if the strand of the O-ring is cut through). For example, the O-rings may be made from rubber, silicon, plastic, or any other like type of flexible material known to those of ordinary skill in the art. The O-rings may have a cross-sectional profile that is round, oval, rectangular, triangular or other cross-sectional shapes known to those of ordinary skill in the art.

FIG. **13** depicts a number of different types of lifting devices suitable for use with the various embodiments. For example, the various embodiments of a lifting head disclosed herein may be used in conjunction with a multi-post overhead lift **77** (e.g., two-post overhead lift, four-post overhead lift, etc.), a farm jack **79**, a bumper jack **81**, a screw jack **83**, a trailer jack **85**, a floor jack **87**, a forklift jack **89**, a pallet jack **91**, a lifting bag **93**, a jack stand **95**, a scissors jack **97** and a toe jack **99**. Each of the various types of lifting devices **77**-**99** has one or more lifting members **77***a*-**99***a* that can be controlled to move up and down to lift various sorts of objects. For example, as a user twists the handle of screw jack **83** the threaded lifting member **83***a* of the screw jack moves up or down. Similarly, as a user pumps the handle of floor jack **87** the lifting arm **87***a*-*a* lifting member-moves up or down to lift or lower an object such as an automobile. The various embodiments disclosed herein may be implemented with other types of lifting devices not depicted in FIG. **13** that are known to those of ordinary skill in the art.

The terms "up," "upward," "down" and "downward" are used throughout this disclosure to aid in describing and explaining the various embodiments. These terms are to be taken relative to the pull of gravity towards the center of the earth. For example, upward is a direction pointing directly away from the center of the earth. The term "horizontal" is a direction orthogonal to upward/downward. If "horizontal" is used to describe a part or line on a device, it implies a direction of the part or line for the device sitting in its normal or intended state—for example, a bottle jack sitting upright with its base resting on a flat floor. The term "vertical" is used to describe a direction orthogonal to horizontal. The term "slightly less than" is defined to mean "at least 90% of". For example, the diameter of a threaded bushing that is slightly less than the piston cavity diameter is at least 90% of the piston cavity diameter. The term "approximately" as used herein means plus or minus as much as 5%. For example, a first component that is approximately the same length as a second component is within +/−5% of the second component's length. The term "removably attached" is used herein the mean that two parts (or components, elements, etc.) are attached to each other, but may be unattached without destroying or damaging either part. A nut can be removably attached to a bolt. But two metal parts welded on to each other are not said to be removably attached.

The present invention may be embodied in other specific forms without departing from its purposes, functions, structures, or operational characteristics. The described embodiments are to be considered in all respects only as illustrative, and not restrictive. The scope of the invention is, therefore, indicated by the appended claims, rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

The invention claimed is:

1. An apparatus configured for use with a lifting device that includes a lifting member with a head cavity, the apparatus comprising:

a lifting head configured to at least partially fit within the head cavity of the lifting member, wherein the head cavity is a multi-diameter head cavity with an upper portion characterized by an upper wide diameter and lower portion characterized by a lower narrow diameter;

a lifting shaft configured as part of the lifting head, the lifting shaft having a round shaped cross-section and a length that exceeds its circumference, the lifting shaft being configured to fit at least partially within the head cavity and extend out of the head cavity in an upward direction;

a yoke configured as part of the lifting head and connected to the lifting shaft, the yoke having a yoke width and a yoke depth, the yoke width being at least four times as long as the yoke depth; and

a threaded bushing with an outside diameter slightly less than the upper wide diameter and wider than the lower narrow diameter;

wherein the lifting shaft is retained at least partially within the head cavity by gravity, and is removable from the head cavity without tools, a load path passing from the lifting shaft to the lifting member.

2. The apparatus of claim **1**, wherein the lifting device has an O-ring fitted around the inside of the head cavity to aid in retaining the lifting shaft within the head cavity.

3. The apparatus of claim **1**, further comprising:

one or more cylindrical risers each with a central axis hole shaped to receive the lifting shaft.

4. The apparatus of claim **3**, wherein the one or more risers is a plurality of risers;

wherein the plurality of risers are configured to stack on each other with the lifting shaft extending upward from the lifting device through the central axis hole of each of the plurality of risers; and

wherein the lifting member is controllable by a user to move up and down.

5. The apparatus of claim **1**, wherein the threaded bushing has a groove around its outer circumference, the apparatus further comprising:

a flexible collar with an inside diameter slightly less than the outside diameter of the thread bushing, the flexible collar being configured to fit within the groove.

6. The apparatus of claim **5**, wherein, upon the threaded bushing being inserted into the head cavity, the flexible collar contacts side walls of the upper portion of the head cavity to aid in keeping the flexible collar stationary with respect to the lifting member.

7. The apparatus of claim **1**, wherein the lifting device is a bottle jack and the lifting member is a piston, the bottle jack comprising:

a base;

a containment vessel sealed to the base;

a cylinder within the containment vessel;

a pump connected between the cylinder and the containment vessel;

a system of valves controlling movement of hydraulic fluid between the containment vessel, the pump, and the cylinder; and

a shoulder configured as part of the lifting head, the shoulder being positionable in direct contact with an annulus.

8. The apparatus of claim **1**, wherein the lifting device is a type selected from the group consisting of a multi-post overhead lift, a farm jack, a bumper jack, a screw jack, a trailer jack, a floor jack, a forklift jack, a pallet jack, a lifting bag, a jack stand, a scissors jack and a toe jack.

9. A method of manufacturing a lifting apparatus having a head cavity formed within a lifting member, the method comprising:

providing a lifting head configured to at least partially fit within the head cavity of the lifting device, wherein the head cavity is a multi-diameter head cavity with an upper portion characterized by an upper wide diameter and lower portion characterized by a lower narrow diameter;

providing a threaded bushing with an outside diameter slightly less than the upper wide diameter and wider than the lower narrow diameter;

providing a lifting shaft configured as part of the lifting head, the lifting shaft having a round shaped cross-section and a length that exceeds its circumference, the lifting shaft being configured to fit at least partially within the head cavity extending upward out of the head cavity in an upward direction; and

providing a yoke configured as part of the lifting head and connected to the lifting shaft, the yoke having a yoke width and a yoke depth, the yoke width being at least four times as long as the yoke depth;

wherein the lifting shaft is retained at least partially within the head cavity by gravity, and is removable from the head cavity without tools, a load path passing from the lifting shaft to the lifting member; and

wherein the lifting member is controllable by a user to move up and down.

10. The method of claim **9**, further comprising:

fitting an O-ring fitted around the inside of the head cavity of the lifting device to aid in retaining the lifting shaft within the head cavity.

11. The method of claim **9**, further comprising:

providing a plurality of cylindrical risers each with a central axis hole shaped to receive the lifting shaft;

wherein the plurality of risers are configured to stack on each other with the lifting shaft extending upward from the lifting device through the central axis hole of each of the plurality of risers.

12. The method of claim **9**, wherein the threaded bushing has a groove around its outer circumference, the method further comprising:

providing a flexible collar with an inside diameter slightly less than the outside diameter of the thread bushing, the flexible collar being configured to fit within the groove.

13. The method of claim **12**, wherein, upon the threaded bushing being inserted into the head cavity, the flexible collar contacts side walls of the upper portion of the head cavity to aid in keeping the flexible collar stationary with respect to the lifting member.

14. The method of claim **9**, wherein the lifting device is a type selected from the group consisting of a multi-post overhead lift, a farm jack, a bumper jack, a screw jack, a trailer jack, a floor jack, a forklift jack, a pallet jack, a lifting bag, a jack stand, a scissors jack and a toe jack.

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